The Department of Defense

DoD DEPARTMENTS:

Department of the Army

Department of the Navy

PROGRAM SOLICITATION 95.3
CLOSING DATE: 07 JULY 1995

FY 1995 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 95.3

Small Business Innovation Research Program

IMPORTANT

The DoD is updating its SBIR Mailing list. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form will result in no future mailings of the DoD SBIR Program Solicitation to your address.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: July 7, 1995

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army and Navy hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

SBIR Coordinator
U.S. Department of Defense
OSD/SADBU - The Pentagon, Room 2A340
Washington, DC 20301-3061
(800) 382-4634

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
Building 5, Cameron Station
Alexandria, Virginia 22304-6415
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6903 commercial

This solicitation is also available on floppy diskette (in Word Perfect) from DTIC for a nominal processing fee. See Section 7.1 for information about Internet access to the solicitation at DTIC.

The DoD SBIR solicitation can be obtained electronically using Business Gold, the National Technology Transfer Center's bulletin board system. Connect via Internet by telneting to **iron.nttc.edu**, or by dialing (304) 243-2560 for high speed modems (9600+) or (304) 243-2561 for 1200-2400 baud modems and logging in as guest. For more information on the NTTC electronic

bulletin board system contact:

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) will not be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete RED COPY of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete RED COPY of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal.

The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential private sector application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some

items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

n. Company Commercialization Report of Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and commercialization status for each Phase II. All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing

interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research (see Company Commercialization Report, Section 3.4.n),
(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,
(3) the existence of third phase follow-on commitments for the subject of the research, or
(4) the presence of other indicators of commercial potential of the idea.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than January 1, 1996. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 286 Phase I awards from this solicitation.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. See special instructions for each DoD Component in Section 8.

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. See special instructions for each DoD Component in Section 8.

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A Sample SF 298 is provided in Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:

- (a) Distribution authorized to U.S. Government Agencies only; report contains proprietary data produced under SBIR contract. Other requests shall be referred to the performing organization in Block 7 of this form.
- (b) Approved for public release; SBIR report, distribution unlimited.

(3) The report abstract (Block 13 of the SF 298, "Report Documentation Page") must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract may be published by the DoD, it must not contain any proprietary or classified data.

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted within the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, Cameron Station, Alexandria, VA 22304-6145.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under

which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a period of four years to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of four years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the four-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252-227-7013 alternate II(3) "Government Purpose License Rights".

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 13, 1995. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than June 30, 1995 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC, a major component of the DoD Scientific and Technical Information Program, serves DoD and other federal agencies and their contractors by providing access to and transfer of scientific and technical information resulting from and describing DoD-funded research and development.

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs). IACs are concerned with the Scientific and Technical Information content of worldwide engineering, technical and scientific documents and databases. Contact DTIC for more information on obtaining technical assistance through the IAC program.

The information assistance provided by DTIC enables organizations preparing R&D proposals to DoD to make better-informed bid decisions and technically stronger submittals.

DTIC prepares a Technical Information Package (TIP) for most SBIR topics. TIPs contain a bibliographic listing of technical reports from DoD-funded work in technical areas related to the SBIR topic. TIPs may also include additional information provided by the topic author and references to other information sources.

Firms responding to this solicitation are encouraged to use Reference B at the back of this solicitation or telephone, fax, or EMail DTIC for background information covering their proposal topic areas. DTIC will return the requested material, annotated with a temporary user code

for use when requesting additional information or when ordering technical reports cited in a bibliography. To support SBIR proposal preparation, reasonable quantities of technical reports from the DTIC collection are available at no cost.

TIPs are also available on Internet, from the DTIC Home Page, under SBIR at: http://www/doc.dtic.dla.mil, using a world wide web-capable browser.

Current DoD SBIR and STTR solicitations as well as the Phase I and Phase II Award Abstracts publications are accessible on Internet, via gopher at: gopher.dtic.dla.mil on port 70, or at: asc.dtic.dla.mil for file transfer. FTP login is "anonymous", password is your E-Mail address, SBIR files are in the /pub/sbir directory.

If clarification of highly-specific technical points in the technical topic descriptions in section 8.0 of this solicitation is required, assistance may be requested using the DTIC SBIR Interactive Technical Information System (SITIS), an anonymous electronic forum between participant small businesses and the DoD scientists and engineers assigned to SBIR topics. SITIS is accessible by Lynx, FTP, EMail, fax, paper mail, telephone, or on world wide web at: http://dticam.dtic.dla.mil/www/welcome.html, the MATRIS Home Page. For more information on SITIS, contact the SBIR Coordinator at the DTIC MATRIS location given below.

Call, or visit (by prearrangement) DTIC at the location most convenient to you. All written communications must be made to the Alexandria, Va., address.

Defense Technical Information Center
ATTN: DTIC-User Services (SBIR)
Bldg 5, Cameron Station
Alexandria VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-9274 (FAX)
EMail sbir@dgis.dtic.dla.mil

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(513) 255-7905

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

DTIC Manpower and Training Research Information System (MATRIS) provides information services in the areas of manpower, personnel, training and simulation devices, human factors and safety. MATRIS operates the SBIR Interactive Technical Information System (SITIS). For information contact:

Defense Technical Information Center
DTIC-AM, MATRIS Office
ATTN: SBIR Coordinator
53355 Cole Rd.
San Diego, CA 92152-7213
(619) 553-7000
(619) 553-7053 (FAX)
EMail sbir@dticam.dtic.dla.mil

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77843-8000
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:
- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B and C follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, and Appendix C is an outline for the Cost Proposal. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

U.S. ARMY 95.3
SUBMISSION OF PROPOSALS

Topics

The Army participates in one solicitation each year with a coordinated Phase I and Phase II proposal evaluation and selection process. The Army has identified 126 technical topics for this solicitation which address the Technology Areas in the Defense Technology Plan and the Army Science and Technology Master Plan. The commercial potential for each of these topics has also been identified.

Technology Areas

Below is a listing of the Science and Technology Areas. Descriptions of these areas are provided on the following pages.

1	Aerospace Propulsion and Power
2a	Air Vehicles
2b	Space Vehicles
3	Battlespace Environments
4	Biomedical
5	Chemical and Biological Defense
6	Clothing, Textiles, and Food
7	Command, Control, and Communications (C3)
8	Computing and Software
9	Conventional Weapons
10	Electronics
11a	Electronic Warfare
11b	Directed Energy Weapons
12a	Environmental Quality
12b	Civil Engineering
13	Human Systems Interface
14	Manpower, Personnel, and Training
15	Materials, Processes, and Structures
16	Sensors
17a	Surface/Under Surface Vehicles-Ships and Watercraft
17b	Ground Vehicles
18	Manufacturing Science & Technology (MS&T)
19	Modeling and Simulation (M&S)

Proposal Guidelines

The maximum dollar amount for Army Phase I awards is $70,000 and for Phase II awards is $600,000. Selection of Phase I proposals will be based upon technical merit; evaluation procedures and criteria are discussed in this solicitation document. Due to limited funding, the Army reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded. To reduce the funding gap between Phase I and Phase II, the Army follows a disciplined milestone process for soliciting, evaluating, and awarding superior Phase II proposals. Phase II proposals are invited by the Army from past and ongoing Phase I projects which have demonstrated the potential for commercialization of useful products and services. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing developed technology. Cost sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged. Commercialization plans and cost sharing provisions will be considered in the evaluation and selection process. Phase II proposers are required to submit a budget for a base year (first 12 month) and an option year. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered.

Key Dates

July 7, 1995	Solicitation 95.3 Closes (Deadline for Phase I proposal submission)
September 30, 1995	Deadline for Phase II proposal submission to Army (from past and ongoing Phase I projects) Please Note: All Phase II proposals received after 30 September will not be considered
December 8, 1995	Phase I and Phase II Proposals Selected for Award
January 15, 1996	Phase I and Phase II Notification of Awards
January/February 1996	Phase I and Pahase II Contracts Executed

Recommendation of Future Topics

Small Businesses are encouraged to suggest ideas which may be included in future Army SBIR solicitations. These suggestions should be directed at specific Army research and development organizations.

Inquiries

Inquiries of a general nature should be addressed to:

LTC John Peeler (inquiries only)
Army SBIR Program Manager
HQDA
OASA RDA
Pentagon, Room 3E486
Washington, D.C. 20310-0103
(703) 697-8432

Dr. Kenneth A. Gabriel
Army Research Office--Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

DESCRIPTIONS OF THE TECHNOLOGY AREAS

Area 1: *Aerospace Propulsion and Power*

The Aerospace Propulsion and Power technology area includes those efforts directed toward propulsion and power systems for aircraft, missiles, and space vehicles. There are four major sub-areas: Integrated High Performance Turbine Engine Technology (IHPTET), focused on gas-turbine propulsion systems for aircraft and cruise missiles; Integrated High Payoff Rocket Propulsion Technology (IHPRPT), focused on propulsion systems for space and missile systems; high-speed propulsion and fuels, focused on ramjet, scramjet, combined-cycle propulsion systems for missiles and space-launch systems, and fuels; and aerospace power, focused on non-propulsive power generation systems for aircraft, missiles, and space vehicles.

Area 2: *Air Vehicles*

The Air Vehicles Area, which provides affordable, global delivery of people, supplies, weapons and sensors, is divided into fixed wing vehicles, rotary wing vehicles, unmanned air vehicles and system integration technology. Technology efforts are aeromechanics, flight controls, subsystem, air vehicle structures.

Area 2b: *Space Vehicles*

The technologies assembled under the Space Technology Area are those oriented toward the spacecraft bus, as opposed to payload; technologies unique to space and the military; and their implementation thru flight experiments. The Space Technology Area has eight sub-areas: propulsion, focused power, thermal management, advanced materials, survivability, navigation, integration, and flight experiments.

Area 3: *Battlespace Environments*

The Battlespace Environments technology area encompasses the study, characterization, prediction, modeling, and simulation of the terrestrial, ocean, lower atmosphere, and space/upper atmosphere environments to understand their impact on personnel, platforms, sensors, and systems; enable the development of tactics and doctrine to exploit that understanding; and optimize the design of new systems.

Area 4: *Biomedical*

Biomedical S&T (BST) programs are focused to yield superior technology in support of the DoD mission to provide health support to U.S. military forces. Defense BST programs are aligned to the following seven functional areas: infectious disease of military importance, combat casualty care medical biological defense, medical chemical defense, military operational medicine, military dentistry, and ionizing radiation bioeffects.

Area 5: *Chemical and Biological Defense*

The purpose of Chemical and Biological Defense research is to develop equipment that will protect our forces, sustain combat operations, and maintain system effectiveness in a chemical and biological contaminated environment. The chemical and biological defense technology area includes four major subareas: detection, protection, decontamination, and information processing and dissemination.

Area 6: *Clothing, Textiles, and Food*

The DoD Clothing, Textiles, and Food technology area focuses on protecting and sustaining soldiers, sailors, airmen and marines, individually and collectively. This technology area is comprised of two sub-areas: clothing and textiles, and food. The clothing and textiles sub-area includes all textile-related polymer, fiber, yarn, fabric, film, dye, pigment, coating, textile based technologies, and clothing systems, as well as the products' packaging which should enhance survivability, performance, and mobility. The food sub-area includes nutritional performance enhancement, food preservation, food packing, consumer acceptance, and equipment and energy technologies.

Area 7: *Command, Control, and Communications (C3)*

This science and technology area encompasses Command, Control, and Communications systems of all types: data processing hardware and software dedicated to operational planning, monitoring or assessment (including information fusion), distributed processing, distributed data storage, and distributed data management.

Area 8: *Computing and Software*

The Computing and Software Technology Area enables the creation of a broad range of advanced information processing systems of critical value in support of the missions of the Department of Defense (DoD). The Computing and Software area can be broadly grouped into six major subareas: system software, software and systems development, intelligent systems, user interface, computing systems and architecture, and networking.

Area 9: *Conventional Weapons*

The Conventional Weapons Area develops conventional armaments technologies for all new and upgraded non-nuclear weapons. It includes efforts directed specifically toward non-nuclear munitions, their components and launching systems, guns, bombs, guided missiles, projectiles, special warfare munitions, EOD devices, mortars, mines, countermine systems, torpedoes, and underwater weapons along with their associated combat control. There are six major sub-areas: fuzing/safe and arm; guidance and control; guns; countermine/mines; warheads and explosives; and weapon lethality/vulnerability.

Area 10: *Electronics*

The Electronics Technology Area extends from basic research to applications at the subsystem level. Electronics includes the research, development, design, fabrication, and testing of electronic materials; electronic devices, including digital, analog, microwave, optoelectronic, vacuum and integrated circuits; and electronic modules, assemblies, and subsystems. The Electronics Technology Area is organized into five major sub-areas: RF components, electro-optics, microelectronics, electronic materials, and electronic models and subsystems.

Area 11a: *Electronic Warfare*

The Science and Technology Program in the Electronic Warfare (EW) area develops technology for the offensive and defensive application of EW. It includes efforts to intercept, counter, and exploit the complex threat weapons spanning the entire electromagnetic spectrum, including radio frequency (RF), infrared (IR), electro-optic (EO), ultraviolet (UV) and multispectral/multimode sensors. These technologies are applied within three subareas: force protection, offensive EW, and EW support functions.

Area 11b: *Directed Energy Weapons*

Directed Energy Weapon (DEW) technologies are those that relate to the production and projection of a beam of concentrated electromagnetic energy or atomic/subatomic particles. Directed energy (DE) weapons and devices generate energy that travels at or near the speed of light from a beam source directly to the target. The DEW Technology Area is divided into three sub-areas: laser weapons, RF weapons, particle beam weapons, or charged atomic or sub-atomic.

Area 12a: *Environmental Quality*

The Environmental Quality technology area provides technologies to reduce the costs of DoD operations while ensuring mission accomplishment is not jeopardized by adverse environmental impacts. There are four sub-areas: cleanup of contaminated sites, compliance with all laws, prevention of pollution, and conservation.

Area 12b: *Civil Engineering*

The Civil Engineering Technology Area efforts solve critical DoD civil engineering problems related to training, mobilizing, deploying, and employing a force at any location at any time. This technology area includes survivability and protective structures, airfields and pavements, conventional facilities, critical airbase facilities and recovery, ocean and waterfront facilities and operations, sustainment engineering, and fire fighting.

Area 13: *Human Systems Interface*

Human Systems Interface (HSI) technology fully leverages and extends the capabilities of warfighters and maintainers to ensure that fielded systems will exploit the fullest potential of the warfighting team, irrespective of gender, mission or environment. It is organized into four areas: crew systems integration and protection, performance aiding, information management and display, and performance assessment and design methodologies.

Area 14: *Manpower, Personnel, and Training*

The Defense Manpower, Personnel, and Training science and technology program seeks to maximize human military performance. Manpower and personnel addresses the recruitment, selection, classification, and assignment of people to military jobs by seeking to reduce the attrition of high-quality personnel and helping the senior department leadership to predict and measure the consequences of policy decisions. Training systems technology improves the effectiveness of the instruction, the efficiency of student flow through the training pipeline, military training systems, and provides opportunities for skill practice and mission rehearsal, for a lower life-cycle cost.

Area 15: *Materials, Processes, and Structures*

Materials, Processes, and Structure (MP&S) technologies produce an enabling array of capabilities for every DoD system that flies, navigates, and fires or is fired upon. MP&S technologies are equally critical in maintaining the DoD infrastructure, from military piers and trucks to sophisticated sensors and optical systems, and in reducing the impact of defense systems on the environment. MP&S spans all material categories--metal and intermetallic alloys; ceramics; polymers; composites of all types; semiconductors; superconductors; optical, ferroelectronic, and magnetic materials; and materials for power sources.

Area 16: *Sensors*

The Sensors technology area develops technologies in five major subareas: radar sensors, electro-optic sensors, acoustic sensors, automatic target recognition, and integrated platform electronics and sensors. Applications include strategic and tactical surveillance, identification and targeting of threats from all military platforms including satellites, aircraft, helicopters, ships, submarines, ground vehicles and sites, unmanned air vehicles, unattended ground sensors and the individual soldier.

Area 17a: *Surface/Under Surface Vehicles-Ships and Watercraft*

The Ships and Watercraft Technology Area provides the technology for improved combat efficiency, survivability, and stealth of surface ships, submarines and unmanned undersea vehicles.

Area 17b: *Ground Vehicles*

The Ground Vehicles Technology Area incorporates technologies to support the basic Army and Marine Corps land combat functions: shoot, move, communicate, survive and sustain. Covered here are propulsion and power, track and suspension, vehicle subsystems, hydrodynamics, signature reduction, fuels and lubricants and integration technologies related to land combat vehicles, including amphibious vehicles with a ground combat role.

Area 18: *Manufacturing Science & Technology (MS&T)*

The Manufacturing Science and Technology area is focused on cross-cutting engineering and manufacturing process technologies beyond those developed in conjunction with new product technologies in the other technology areas: advanced technology demonstrations for affordability, and advanced industrial practices to demonstrate the combination of improved process technology and improved business practices, programs encompass technologies at all manufacturing levels (enterprise/factory/cell/machine/unit process).

Area 19: *Modeling and Simulation (M&S)*

The Modeling and Simulation technology area includes development, integration, and implementation of tools and applications to apply M&S with greater validity across DoD. Efforts are directly dependent on enabling technologies such as high speed computing, communications and networking, human systems technologies such as high speed computing, communications and networking, human systems interfaces, and software.

ARMY SMALL BUSINESS INNOVATION RESEARCH
Submitting Proposals on Army Topics

Phase I proposal (5 copies including 1 red-printed form) should be addressed to:

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ARMY SBIR PROGRAM
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DEPARTMENT OF THE ARMY
FY 1995 TOPIC DESCRIPTIONS

A95-001 TITLE: Automated Compression Forming for Continuous Fiber Reinforced Composite Structure

CATEGORY: Exploratory Development

OBJECTIVE: To foster the development of an integrated fabrication process consisting of an advanced weaving technology to produce net-shaped tailored fabric, an automated compression forming process and a non-autoclave curing process using electro-beam radiation. An integrated fabrication process will facilitate the creation of complex structural parts without sacrificing structural performance while minimizing labor, tooling and material cost. Such a process will greatly reduce the high fabrication costs currently associated with composite structures.

DESCRIPTION: The broad application of continuous fiber reinforced structures has been severely restricted due to the high fabrication cost associated with these materials. Multiple rolls of net-shape fabric can be assembled to form a structural preform using a compression forming process similar to that used in a metal stamping process. During the compression forming process the resin is injected into the fabric preform and after full wet out of the preform the resin solidifies. An alternative approach to resin injection is the use of resin powder coating on the structural fibers prior to weaving the fabric. Once the resin has solidified, but is uncured, the structural part is cured using electron-beam radiation. Electron-beam curing eliminates the necessity of tooling and bagging of the structure during the cure process.

PHASE I: Develop a process for forming a multi-layer composite structural part consistent with the aforementioned fabrication process. The forming process may be a multi-step process consisting of a partial debulking step followed by a final debulking and resin injection/melting and solidification step. The individual elements of this process shall be demonstrated without attempting to fully automate the process; however, the processes must be fully integrateable.

PHASE II: Integrate the separate fabrication steps into an automated process minimizing the total fabrication costs associated with the process. Demonstrate the fabrication process by fabricating multiple complex structural elements. Fabrication cost analysis shall be performed using this technology. The structural part shall be electron-beam cured and undergo destructive evaluation to assess its structural performance.

POTENTIAL COMMERCIAL MARKET: An integrated fabrication process which minimizes labor, and the use of autoclaves, while reducing tooling and material cost will greatly reduce the current high composite fabrication cost. Once developed new markets for these materials will rapidly evolve.

A95-002 TITLE: Non-Destructive Evaluation Technology for Determining Bonding Integrity for Joining Materials at Micro-Level

CATEGORY: Exploratory Development

OBJECTIVE: The principal objective of this effort is to develop and demonstrate a non-contact technology for determining bonding integrity of materials at the micro-level. This sensor must be fast enough to support high speed manufacturing processes used in its field. Example applications include diamond coating, delamination of thick or thin film traces, lid sealing of microcircuit packages etc.

DESCRIPTION: The long-term trend in microelectronic, semiconductor and electronic industries is smaller, denser, and faster with each generation and is approaching some serious defect levels. One of the obstacles in reducing the defect level is the inability to detect micro flaws on materials, at high speed and resolution, during its manufacturing process. Due to the fragility of its structure and crucial positioning of its interconnects, traditional contact sensors are losing their effectiveness in terms of speed and dexterity. Mechanical pull/shear, machine vision and X-rays are ineffective technologies for our applications. A high speed and high resolution sensor for determining the presence, absence and degree of attachment of micro-joints will be developed under this effort.

PHASE I: Requires research and development of an innovative concept using relevant sensor technologies for determining micro-bonding integrity at high speed and resolution. This concept must be technologically feasible and meet the objectives of reducing quality control costs, manufacturing bottle necks, and be suitable for automated process control.

PHASE II: Prototype of the proposed sensor in Phase I will be designed and built based on results of the Phase I effort. Deliverable would include a complete design analysis, design documentation package, and a prototype station suitable for test and evaluation, using appropriate assemblies supplied by the Army. The contractor will participate in the evaluation tests to guarantee the system is working at full capability and provide timely modification as needed to optimize system performance.

POTENTIAL COMMERCIAL MARKET: New knowledge and technology advances resulting from this development will enable us to monitor and explore material behaviors before, during and after its manufacturing or assembly processes. It will provide a stepping stone for much broader applications in the field of material processing. Industries that can use this sensor technology for process control improvements and controls include military, aerospace, commercial electronics, microelectronics, metal working, composites, printed circuit manufacturing, thick film & thin film circuits and plastics. Cost savings are realized by eliminating post-process inspection, reduce scrape, reduce rework, improve throughput time, and above all allow real-time process monitoring and control.

A95-003 TITLE: Processing of Advanced Lightweight Metals, Ceramics and Composites Thereof

CATEGORY: Exploratory Development

OBJECTIVE: Develop technologies capable of enhancing the economic processing of advanced materials for lightweight vehicle applications.

DESCRIPTION: Innovative developments on advanced lightweight metals, ceramics and metal matrix composites processing technologies could be applied to fulfill significant current and future Army needs. Proposals are sought on such developments that address the Army needs and technology opportunities described in the following. Each proposal must be responsive to a single materials area with the Army as well as the commercial need/s clearly delineated. * Low cost titanium for ground vehicle applications * Functionally gradient ceramic-metal materials for armor * Powder injection molding of net-shape metal and ceramic components * Scalable process for production of low-cost, fine (less than 5 micrometers) powders of titanium diboride, silicon carbide, and boron carbide for armor ceramics * Reduction of hot-pressing densification temperatures of armor ceramics * Energetic (Laser/Ion) beam treatments and coatings for enhanced tribology and armor performance

PHASE I: Demonstrate the feasibility of applying innovative concepts to advanced lightweight materials on simple components and deliver samples to the Army for evaluation

PHASE II: Optimize, scale-up and validate the processing technology pursued in Phase I. Develop prototype equipment and demonstrate its capability to meet quality, production quantity and reproducibility goals by producing and delivering prototype components for Army evaluation, and assess industrial production costs.

POTENTIAL COMMERCIAL MARKET: The commercial potential of innovative developments that enhance processing of advanced lightweight metals extends into many industries. Applications in the areas of light vehicles will save enormous amounts of energy and natural resources without sacrificing safety and durability. Other applications include aircraft, engines and bearings.

A95-004 TITLE: Dendrimer-Based Protective Coatings for DoD Materiel

CATEGORY: Exploratory Development

OBJECTIVE: Develop dendrimer-based protective coatings that are resistant to POL (petroleum, oil, and lubricant) degradation and chemical agent contamination, and scale up production to a commercial level.

DESCRIPTION: Dendritic polymers are a relatively new class of nanostructures that, unlike linear polymers, are prepared with precisely controlled properties such as size, shape, and surface reactivity. Because of the precisely controlled architecture, they can be thought of as molecular building blocks that can be designed to create molecular scale devices or that can be "assembled" to form mesoscale materials (nanometer to micron range). Although kilogram-scale production is reportedly in progress, few commercial applications have been precisely defined. This solicitation seeks research to develop dendrimer-based coatings that are mechanically tough with repellent or resistant properties of interest to DoD. A number of approaches are possible including using dendrimers as a component in a coating or material, tailoring dendrimer chemistry to attach dendrimers directly to surfaces, or chemically reacting dendrimers to form mesoscale or network materials. Of particular interest are coatings that are environmentally stalwart over time which repel or resist POLs and chemical agent contamination.

PHASE I: Develop dendrimer coatings that are environmentally robust and are resistant to POLs and chemical agent

contamination.

PHASE II: Based on the results of Phase I, fine tune the repellent/resistant properties of the coatings for specific DoD applications in conjunction with the U.S. Army and test the coatings on DoD materiel. Scale up production to a commercial level.

POTENTIAL COMMERCIAL MARKET: Dendrimer coatings would protect DoD materiel such as vehicles and weaponry from chemical agent contamination and degradation due to POL and environmental exposure. For DoD and the civilian sector, the coatings would provide protection during environmental clean-up operations, and protect vehicles, aircraft, and other equipment from wear and degradation due to environmental and POL exposure. Dendrimer-based materials have diverse potential applications including as detection devices for chemical agents and environmental toxins, for catalytic detoxification of chemical agents and chemical waste, as lubricating, protecting, and barrier coatings, as adhesives, filters, membranes, reinforced polymer composites, insulating materials, as controlled release materials for drug delivery, agricultural applications, and stimulated lubrication, and for electronics and optical device applications.

A95-005 TITLE: Supercritical Fluid Production of Polyphosphazene Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop a supercritical fluid synthesis of polyphosphazenes, characterize the process and products, and scale up the process for economical commercial production.

DESCRIPTION: Polyphosphazenes are a class of polymeric materials that have numerous potential uses including as high performance elastomers (rubbery materials), membranes, fire resistant materials, optical materials, and biomedical materials. The large number of diverse applications for this class of polymers is due to tailoring the material properties by substituting a variety of different substituents onto the polymer backbone. While research continues on the synthesis of new materials and variations to synthetic strategies, to date there are few polyphosphazene products commercially available due to the relatively high cost of production. This solicitation seeks the development of a supercritical fluid pathway for polyphosphazene synthesis. This methodology has yet to be applied to polyphosphazene production although success has been demonstrated for other polymers of commercial interest. It is expected that supercritical fluid synthesis can be a cost effective means for producing well defined polyphosphazene based materials of interest to DoD and the civilian sector. A supercritical fluid pathway will eliminate the relatively large quantity of waste products associated with polyphosphazene production.

PHASE I: Develop a supercritical fluid means to economically produce polyphosphazenes of interest to DoD and characterize the process and resultant materials.

PHASE II: Scale-up the approach developed in Phase I to produce polyphosphazene based materials with well-defined properties of interest to DoD, including solvent resistant materials, materials stable at high temperatures, materials which remain flexible at low temperatures, and flame resistant materials. Polyphosphazene-based components will be produced and tested in conjunction with the U.S. Army.

POTENTIAL COMMERCIAL MARKET: These materials have potential applications for DoD and the civilian sector as vehicle and equipment components including high performance materials, solvent and oil resistant materials, seals, gaskets, o-rings, and belts, as fire resistant materials for use on aircraft and on ships, as membranes for chemical protection, as biomedical materials, and as drug delivery systems.

A95-006 TITLE: Application of Coatings to Advanced Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop affordable coatings to complement materials applicable to advanced gas turbine engines and thus, allow increased capability and optimum benefit of the material employed to be realized.

DESCRIPTION: A significant opportunity exists in the application of advanced materials to many components of industry/Government gas turbine engines. The use of advanced materials will enable significant increases in power-to-weight ratios and reductions in specific fuel consumption. For example, ceramic matrix composites (CMC) are being utilized for turbine shrouds and high temperature titanium aluminides, such as super alpha 2 and orthorhombic titanium aluminides, are being employed in the impeller. However, associated with the application of these advanced materials is the need for new coatings which, depending on the application/material, would allow increased capability of the component to be realized. As with the

aforementioned examples, if a turbine shroud were fabricated with a CMC then a slight rub could cause fiber damage/breakage, thus an abradable coating would be desirable to allow for a slight shroud rub by the turbine blade and allow continued operation without performance/life degradation. The application of the advanced high temperature titanium aluminides in the impellers creates an oxidation problem at anticipated use temperatures and would necessitate a coating to prevent oxidation. Additionally, the high rotational speeds encountered in advanced engines increases the stresses due to centrifugal forces in roller bearings and greatly reduces the life of the bearings under typical loads. Application of a hydrodynamic deflection pad bearing is a potential solution to increase bearing life; however, a low friction coating must be developed for the pads. Therefore, the development of new coatings to compliment the application of advanced material applications has high payoff potential for both commercial/Government power generation.

PHASE I: Identify a component/material targeted for an advanced engine application. Assess the current capabilities, define operational requirements and identify the potential benefits which could be accrued through application of a new coating. Investigate several candidate coatings. The coatings must have characteristics consistent with those required in an advanced engine environment. Perform preliminary analysis, tailored to chosen coating/material/ component system, to determine viability of candidate coating systems. Down select to most promising coatings (two or three).

PHASE II: Define test techniques specifically designed to simulate the anticipated operational environment for the selected component/coating systems. Utilizing results of tests, down select to most promising coating. Develop a coating application process. Perform testing of a full scale coated component in a gas turbine rig and/or engine to substantiate benefits achievable.

Phase III: Focus on the commercialization of the coating technology demonstrated in Phase II.

POTENTIAL COMMERCIAL MARKET: The resulting technology will facilitate achievement of engine components having reduced weight, higher temperature capability, and/or increased durability. This technology will prove very beneficial to both the military and commercial sectors, being applicable to a wide variety of applications such as tank, automobile and aircraft primary power, heat exchangers, auxilary power units, etc. The resulting product has a large potential market with enormous cost savings potential.

A95-007 TITLE: Robust Interfaces for Embedded Fiber Optic Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop, characterize, and demonstrate inexpensive, durable (robust) connectors or interfaces for optical fibers which are embedded in advanced aerospace structural materials such as thermoset or thermoplastic composites, metallic alloys and composites, and/or ceramic materials.

DESCRIPTION: Applications for optical fibers that are embedded in aerospace structures and engine components are being developed to the point that in-situ processing monitors, strain sensors, neural networks, etc., are technically feasible. A limiting factor in the development and deployment of embedded fiber optics is the fragility and expense of the fiber optic interface between the component in which the fiber is embedded and the sensing optical or transmitting LED/LASER device. The expense and durability/robustness of connections to tens or hundreds of fiber optic "leads" that may emanate from a single composite structure with an embedded neural network become driving design and practicality issues. It is envisioned that discontinuous optical interfaces (windows or lenses) that could be placed in intimate contact with cleaved or otherwise cleanly terminated fibers would allow optical transmission to occur. Another possibility could be the actual embedment of extremely small LED or LASER diodes and IR or other wavelength receptors within the structure or component, allowing for simple electrical interfaces to signal processing equipment and power sources. The solution to the fiber optic interface problem must be affordable, survivable in high vibration/temperature environments, and not overly constrictive to the design engineering process. Development of robust in-situ fiber optic interfaces will support S&T Thrust #7 Technology for Affordability, and Structural Integrity Program objectives.

PHASE I: An examination of the excitation and sensing light frequencies, amplitudes, and tolerable S/N ratios for various fiber optic applications (which are easily available in the literature) will be conducted to define the minimum transmission requirements for an embedded optical fiber interface. A conceptual design of the interface concept will be performed. A breadboard or prototype interface will be manufactured and tested for baseline performance for the applicable transmission requirement. The overall feasibility of the concept will be evaluated, and improvements/modifications for further development identified. Bi-monthly technical progress reports shall be submitted. A final technical (end of program) briefing shall be presented to the Army at the Aviation Applied Technology Directorate, USAATCOM, AVRDEC, Fort Eustis, Virginia.

PHASE II: The object of this phase will be to demonstrate significant design, manufacturing, and operational use benefits of the fiber optic interface concept compared to current fiber coupling methods. The developed interface concept's

utility and robustness will be evaluated in a simulated or actual manufacturing scenario for one or more types of aerospace components or structures with embedded optical fibers. Specific metrics for evaluation shall include transmissivity, induced noise, durability, and cost. Elimination of any peculiar constraints, such as special care and handling of exposed fiber ends, imposed by the fibers in the manufacturing process will be emphasized.

POTENTIAL COMMERCIAL MARKET: Despite the considerable promise of fiber optics and sensors in composites and other structures or components, the actual implementation of embedded fibers has not been reduced to practice, in part due to the considerable fabrication issues involved with handling of the fiber optic "tails". Small, inexpensive, non-invasive interfaces for embedded optical fibers will eliminate one of the fundamental barriers to implementation of fiber optic sensors and networks in military and other high performance applications.

A95-008 TITLE: Non-Eroding Fin Materials

CATEGORY: Exploratory Development

OBJECTIVE: Advanced missile control systems are currently using fin in plume technologies. Current fin materials erode during system operation making precise flight control difficult. A non-eroding fin material is sought which will provide no erosion or limited reproducible erosion of the fin aerodynamic surfaces.

DESCRIPTION: In order to solve this problem, both monolithic and multiple high temperature fin materials must be considered. Multiple material fins present material incompatibilities during processing and component service which must be understood to provide a successful design. These multi-material configurations induce thermal stresses, and thus are susceptible to flaking and cracking during both processing and service life.

PHASE I: Phase I of this research effort should concentrate on analytical modeling of conceptual fins to define the magnitude of thermal stresses developed during service, residual stresses after processing, and methods of reducing these residual stresses. Multiple material fins should be considered, with composite materials being designed to minimize the residual thermal stresses.

PHASE II: The PHASE II effort should demonstrate the design concepts developed in PHASE I by fabricating and testing several fins. The analytical tools developed in PHASE I should be demonstrated to be capable of predicting the fin material stress states. Combined material and configuration optimization should also be demonstrated in the phase II effort.

POTENTIAL COMMERCIAL MARKET: Development of non-eroding multi-material systems have commercial potential in the turbine and piston engine industries. Other applications include high speed aircraft control surfaces.

A95-009 TITLE: Fiber Optics in Filament Wound Structures

CATEGORY: Exploratory Development

OBJECTIVE: The objective of his task is to develop novel processing technology to incorporate optical fibers in a filament wound composite structure. The purpose of the fiber optics could be to determine displacement, strain or temperature.

DESCRIPTION: Fiber optics in composite structures could be used for a host of areas such as monitoring cure cycle, measuring displacement and strain, and monitoring service life of rocket motorcases. It is not known what the fiber optic can do to the structural integrity of a filament wound structure such as a pressure vessel or rocket motorcase. The positive aspects of fiber optics might be offset by the degradation of the structure. It is important to characterize the effects of an integrally filament wound fiber optic in a composite structure.

PHASE I: Phase I of this research task should concentrate on techniques to place fiber optics in filament wound composites. A series of simple test articles should be identified. Placement and location of the fiber optic should be analyzed for the effects of structural integrity on the test articles.

PHASE II: The simple series of tests identified in Phase I should be made and the results compared with analysis. More complex filament wound structures such as pressure vessels or a rocket motorcase should be manufactured with fiber optics at different locations and tested for structural effects.

POTENTIAL COMMERCIAL MARKET: This type of processing technology could be utilized in the commercial market where there is a need for information from a structure. Manufacturing of commercial composites could use fiber optics as a measure of a cure cycle. An excellent application would be monitoring of the strain of composite rocket motorcases for service life. Some other types of tankage would include swimming pool filters, air plane fuel storage tanks, fireman tankage

and fuel containers.

A95-010 TITLE: Development of New Materials for Small Arms Defeat

CATEGORY: Exploratory Development

OBJECTIVE: To develop new innovative materials for small arms protective body armor.

DESCRIPTION: Current body armor designed to protect against small arms threats typically consist of rigid materials with a reinforcement backing. The strike-face materials are usually metal or ceramics backed with fiber-reinforced composites. This topic specifically seeks to develop new innovative materials to provide protection against small arms threats. Successful materials will have a weight per unit surface area of 5.0 pounds per square foot or less, have a thickness of not more than one inch, and defeat all types of 7.62 ball ammunition at muzzle velocity and 0 degrees obliquity. Attention should also be given to affordable, large-scale production potential.

PHASE I: Identify and develop innovative materials with potential for meeting ballistic performance and weight requirements. Demonstrate potential to meet performance goals through laboratory scale testing.

PHASE II: Optimize selected Phase I candidate/s and demonstrate desired performance in a prototype model. Deliver prototype systems for government evaluation and verification for final acceptance. Provide final technical report with technical data package for optimized materials.

POTENTIAL COMMERCIAL MARKET: This technology will be directly transferable to the law enforcement body armor industry.

A95-011 TITLE: Automatic Fiber Placement (AFP) Process for Polymer Composite Sabots

CATEGORY: Engineering Development

OBJECTIVE: Develop a manufacturing process for composite sabots utilizing Automatic Fiber Placement (AFP) technology.

DESCRIPTION: Current large caliber tank ammunition utilize sabots made from composite materials. The cost of these units is fairly high due to several factors: the initial costs of the prepreg material itself; the manufacturing process requires the cutting and handling of a multitude of small parts; the high scrap rate due to the "sheet stock" form of the prepreg material. AFP has the potential to lower the costs associated with these factors. The material used in this process would be in the un-impregnated state, i.e. raw fiber and resin; thus the cost to produce prepreg is eliminated. The process lays down single strands of fiber to the proper orientation within the part geometry; the material does not have to be prelaminated to orientation like prepreg does. This lowers the scrap rate. An entire preform can be stacked and stitched in one setup thus negating the need to cut, handle and stack a number of smaller parts. Also, this process offers the possibility to easily tailor the architecture of the structure to meet specific needs; this option has yet to be seen with prepreg tape technology. Although the process exhibits great potential, several technical uncertainties exist. Overall material properties must be analyzed for the baseline sabot fiber/resin system. Fiber straightness in the final part is of major concern in the sabot; this issue needs to be addressed. Also, full up sabots would need to be manufactured and tested, both in the laboratory and ballistically, for structural integrity in field conditions.

PHASE I: Determine the feasibility of Automated Fiber Placement by fabricating and testing sample panels. Samples of several material systems will be made with the AFP process and tested against samples made by the current prepreg process. Some samples will be analyzed for their overall integrity and others will be used for mechanical testing. Process parameters will be optimized and a downselect to one material system will be made.

PHASE II: Full scale sabot preforms will be made via the AFP process. These parts will be subjected to destructive laboratory testing for mechanical properties and overall integrity. Should modifications be required, the process will be tailored to the desired architecture. Finally, a group of twenty sabots will be made to the optimized process. This parts will be assembled into full-up cartridges and ballistically tested for structural performance.

POTENTIAL COMMERCIAL MARKET: The AFP process is especially well adapted for the economical manufacture of composite components that have complex shapes or that are subject to complex loading. Examples are housings for aircraft components, mounting blocks, prostheses devices, bicycle wheels, automobile or aircraft seat frames, springs, musical instrument components, etc. In some instances, a single AFP produced part could replace an assembly of multiple parts in the current state of the art. A wheel chair frame is an example of something that could potentially be made as a single piece by the AFP process. A multitude of potential applications exist in the medical, transportation and recreational industries where expensive materials

are used and weight reduction is important.

Mission Relevance: In the current KE cartridge utilizing a composite sabot, the sabot accounts for approximately 46% of the overall cost of the round. By utilizing the AFP process, material and manufacturing costs would be lowered; it is estimated that a 25 - 30% savings can be attained. Also, the flexibility features of the AFP process allows the designer to tailor the part more readily to meet exact needs. As new KE cartridges come under development, both of these issues will allow the Army to field ammunition which meets the exact needs of the user at a reasonable cost.

A95-012 TITLE: Passive Shielding for Low Frequency Magnetic Fields

CATEGORY: Exploratory Development

OBJECTIVE: The intent of this research project will be to design and test a lightweight material to shield low frequency magnetic fields (DC - 10 KHz), emanating from the barrel of an electric gun. This resultant shielding material could be used in other applications, which generate high level magnetic fields at low frequencies.

DESCRIPTION: Systems or facilities hardened to withstand electromagnetic environment effects usually require high-quality electromagnetic (EM) shielding over a broad frequency band. At low frequencies, this is especially a problem for magnetic energy. Usually the low frequency magnetic field shielding requirements involve thick magnetic materials, which drastically increases both the system cost and weight. At present, electric gun barrels use laminated steel to shield these low-frequency magnetic fields. These laminated steel structures add considerable cost and weight to these barrels. Also, the efficiency of the barrel is effected by these steel laminated structures. There is a need for the development of a lightweight material that can be easily installed and maintained that can provide high-performance shielding for electric gun barrels. In the past few years there has been some advancements in the developing of lightweight material, which could be quite useful in the electric gun technology. A material known as Thin-Shield has been developed and tested and results show that it has the shielding properties needed in the proper shielding of electric gun barrels.

PHASE I: Design, develop, and test a shielding material to provide a appropriate shielding electric gun barrels and can be used for power utility application. The shielding will be designed to be used as an outer layer to an existing electric gun barrel. The design criteria will be to provide the shielding with minimum reduction in barrel efficiency (which effects overall system efficiency), minimize shielding weight, thus help minimize barrel weight, and at a lower cost then existing shielding material. Subscale testing will be performed on a test sample to verify that the test sample meets the design requirements before applying the material to the electric gun barrel. The tests will be conducted in accordance with applicable military standards.

PHASE II: The next set of tests (provided material meets design criteria) will be large scale testing where an electric gun will be wrapped with the material and characterized for shielding effectiveness and overall barrel performance. After testing of material for electric gun applications, the material will be tested for power utility applications. Testing will be done by shielding a power utility buss room with the material designed to lower the magnetic field level from approximately 200 milli-gauss (typical level measured in a buss room) to 2 milli-gauss.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program will provide a low cost shielding for schools, residential, office buildings, and any other structures where people would be exposed to undesirable magnetic field levels. The shielding would be made available to the utility companies as well as the general public. The technology would provide the military with a low cost shielding material for vehicles, electric gun barrels, or any other device where magnetic field levels are a hazard to personnel.

A95-013 TITLE: Cubanes - Super Explosives and Potential Pharmaceutical Intermediates

CATEGORY: Exploratory Development

OBJECTIVE: The Cubane molecule shows great potential for both military and pharmaceutical applications. The objective is to develop polynitrocubanes as super explosives and polyfunctionalized (with groups having medical potential) cubanes as pharmaceuticals.

DESCRIPTION: Under ARDEC Tech Base Program, a focused effort is on-going to synthesize octanitrocubane, which is expected to provide about 25-30% more explosive output than LX-14, the Military's most powerful current explosive formulation. Initial screening of cubanes, by National Institute of Health, with a variety of functional groups has shown that these molecules have a strong potential to serve as beneficial pharmaceuticals, viz. as antiviral/anti-AIDS and anti-cancer

compounds, without any toxic effect to normal living cells. Specifically, dipivalyl cubanes showed moderate anti-HIV activity and one of the diphenyl cubanes showed moderate anti-cancer activity. The purpose of this SBIR is to develop appropriately identified cubane derivatives that can be nitrated to yield polynitrocubanes (super explosives) and also evaluated for new pharmaceuticals.

PHASE I: Conduct a detailed literature search and computer modeling studies to select cubane derivatives for nitration as well as for use as potential anti-viral/anti-AIDS and anti-cancer compounds.

PHASE II: Synthesize the target compounds for nitration and conduct an in-depth study of their therapeutic properties.

POTENTIAL COMMERCIAL MARKET: The unique and very challenging chemistry of cubane intermediates which is being developed at ARDEC, for the synthesis of new, more powerful explosives is playing an important role in the search for cubane -based pharmaceuticals. The above narrative clearly points out the commercial potential of this topic. Successfully prepared cubane derivatives which pass as pharmaceuticals can be scaled-up and medically tested. There is an anticipated substantial pay-off of this research to the civilian economy.

References:
1. P.E. Eaton et. al., J. Am. Chem. Soc., 1993., 115, 10195. 2. A. Bashir-Hashemi et. al., J. Chem., 1994, 59, 2132

A95-014 TITLE: Improved Mounting POINT Stress Redistribution of Primary Loads in Composite Structures

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative solutions for stress redistribution at mounting points for primary loads in laminated advanced composite material structures.

DESCRIPTION: The need for improved distribution of primary stresses at mounting points in laminated advanced composite structures has been identified. Design methodologies for laminated composite structures often require global overdesign of a structural member due to the high local stresses experienced at mounting locations for primary loads within the structural member. The development of inexpensive, readily producible local strengthening would yield a greater degree of structural efficiency and reduced weight of primary vehicle structure.

PHASE I: Identify and propose innovative solutions for stress redistribution at mounting points in laminated composite material structures. Perform preliminary analyses and feasibility studies on proposed solutions.

PHASE II: Design, analyze, fabricate and test innovative composite laminate specimens displaying increased stress redistribution efficiency at primary load mounting points in laminated composite material structures.

POTENTIAL COMMERCIAL MARKET: The improvement in the design and fabrication of composite structures resulting from this research has significant potential for future application in primary automotive structures.

A95-015 TITLE: Explosively Bonded Armor Materials

CATEGORY: Exploratory Development

OBJECTIVE: (1) Demonstrate the capability to explosively bond dissimilar armor materials to form a high performance composite of titanium and ultra high hardness steel. (2) Conduct ballistic testing of explosively bonded armors to establish baseline performance relative to conventional armor systems. (3) Establish manufacturing parameters to transition the process to large scale production of these armor arrays.

DESCRIPTION: This effort would establish the applicability of explosively bonded manufacturing techniques to high performance composite armor materials. The use of ultra high hardness steel as an armor material has been demonstrated; however, its use as a structural material is very limited because of its hardness, difficulty in welding, and cracking issues. Titanium is a good structural material with relatively high ballistic performance. The combination of these materials should yield an excellent and economical armor array taking advantage of each components strengths.

PHASE I: (1) Establish baseline parameters to develop sample explosively bonded composites and conduct physical testing to characterize the bond. (2) Develop test samples (nominally 12 inches square) to demonstrate the viability of the process and further characterize the bond quality. (3) Deliver samples to TARDEC for ballistic testing of bonded arrays against small caliber threats to establish V50 data for comparison to conventional armor systems. (4) Submit quarterly progress reports documenting program activities and cost/schedule performance.

PHASE II: (1) Develop manufacturing parameters for production of bonded systems. (2) Conduct a study to determine physical size limitations of the explosive bonding process to establish applicability of bonded systems to either structural or applique armor configurations. (3) Submit quarterly progress reports documenting program activities and cost/schedule performance.

POTENTIAL COMMERCIAL MARKET: Effective bonding of dissimilar materials, such as titanium and steel, will provide substantial dual-use benefits to a number of industries. An example would be bonding in high temperature environments such as automotive engines. Application of this technology to structural steel or titanium structures where performance requirements dictate specific weights and wear or corrosion criteria. (The Japanese are currently using roll bonded titanium clad steel for corrosion protection in sea water environments.)

A95-016 TITLE: Wide Bandgap Gallium Nitride (GaN) Semiconductor Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop high power GaN device technology for the millimeter wave (MMW) and optical sources.

DESCRIPTION: Devices fabricated from GaN have potential to operate at millimeter wave frequencies and demonstrate blue wavelength laser diodes with higher power than those made from traditional narrow band gap semiconductors. If these capabilities can be realized, the technology can be used to build ultra-broad radar & highpower MMW communications. Blue laser diode arrays will allow high power direct pumping of optical countermeasures (OCM) sources, another critical Army need. The robust nature of this material allows for the generation of large quantities of power without the need for external cooling. Thus, devices can be used by special operations forces (SOF) in remote theaters or in other applications where portability is critical. Toward these ends, technical barrier problems in material & process science, fabrication & testing must be surmounted to successfully demonstrate devices.

PHASE I: Should result in plans for surmounting critical deficiencies existing in the state of the art including designs for proof of principle device/s.

PHASE II: Should result in the fabrication and testing of prototype device/s based on technology developed during the course of Phase I.

POTENTIAL COMMERCIAL MARKET: This technology promises dual-use benefits for a wide range of sensors, including medical and navigational sensors. Devices could be used for pumping of commercial light sources, high performance communication links, displays, adverse weather landings, and police operations.

A95-017 TITLE: Optical Modulator for Variable Doppler Frequency Offset of Wideband Microwave Radar Signals

CATEGORY: Exploratory Development

OBJECTIVE: Research and develop an optical modulator capable of variable doppler frequency offset of wideband microwave radar signals.

DESCRIPTION: Optical processing of wideband microwave signals offers the potential for improved performance and reduced system complexity, size, and cost when compared to RF signal processing technology. This is particularly true for wideband microwave radar signal processing applications where signal fidelity, dynamic range, and doppler processing are driving requirements. Using current technology, modulation/demodulation of laser beams using wideband microwave signals is practical, as is the optical amplification and delay of these signals in optical fibers. An important extension of this technology addressed by this research topic is the addition of doppler signal processing capability using purely optical means. Consequently, the objective of this effort is to research and develop an optical modulator capable of effecting a precisely variable doppler frequency offset on a wideband microwave radar signal carried by a modulated laser beam contained in an optical fiber. The technical goals for the optical modulator are as follows: 1. Optical system interface: compatible with Erbium optical amplifiers. 2. RF signal characteristics: a) Frequency Bandwidth: >16 GHz b) Dynamic range (noise floor to input 1 db compression): >40db c) Gain due to optical modulator: >-10db (0 db preferred) d) Gain variation over frequency and temperature range: <1.5db e) Spurious products: -35 dbc or lower f) Doppler frequency range: +/- 500 kHz g) Doppler frequency set-on precision: +/- 20Hz h) Doppler frequency input bandwidth: 10 kHz 3. Operating temperature range: 0 to +50 C 4. Reduced size, power requirements and cost compared to RF technology.

PHASE I: Research, develop and propose a system design with the potential of realizing the goals in the description

above, favoring proven technologies to minimize technical risk. Develop technical specifications for all system components and identify them as commercially available or to be developed. Model and predict the performance of the proposed system, identifying critical components to be developed. Conduct detailed theoretical and/or laboratory investigations on the design and performance of critical components to demonstrate the feasibility and practically of the proposed system design. Deliver a report documenting the research and development effort along with a description of the proposed system and specifications for all system components.

PHASE II: Procure or develop the system components specified in Phase I. Fabricate the prototype optical modulator as proposed in Phase I. Characterize and refine the system performance in accordance with the goals stated in the description above. Deliver the prototype system along with a report documenting the system theory, design, component specifications, performance characterization and recommendations for system refinements.

POTENTIAL COMMERCIAL MARKET: The proposed research and development effort has extremely wide commercial application to wideband microwave signal processing functions in military and commercial radar and communication systems. Examples of commercial doppler processing radar system applications include vehicular collision avoidance, weather, law enforcement, industrial robotics, airborne and space systems.

A95-018 TITLE: High Frequency Solid-State Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced high frequency solid-state millimeter and submillimeter-wave/terahertz and quasi-optical technology.

DESCRIPTION: Small, highly functional and low cost high frequency electronic devices are needed to support emerging thrusts in electronic warfare, communications and digitization of the battlefield. Devices are needed to improve sensor performance for use in all-weather and day/night operations, and enhance target acquisition and situational for both stationary and mobile platforms. Applications for individual small signal, low voltage devices would include man-portable personal communications and object identification. High power devices as part of active device grids or alternative power generation schemes are needed for communications, electronic warfare and cooperative targeting. Control devices are needed for electronic scanning for agile beam steering, target and signal acquisition.

PHASE I: should result in the development of new solid state device concepts and techniques to achieve high frequency performance with increased efficiency and functionality. Complementary analysis, modeling and testing will be used to facilitate development and conceptual design through simulation and evaluation of performance. A proof of concept demonstration is desirable.

PHASE II: will result in the development of the proposed device or technology. Effort will be based on the results obtained in Phase I and lead to a full prototype for demonstration and evaluation. An analysis and evaluation of actual performance will be performed and specific limitations identified. Effort should be consistent with business plan, investment strategy and complementary product development.

POTENTIAL COMMERCIAL MARKET: Lower cost high frequency devices will have enormous impact on wideband wireless communications and local area networks, vehicular sensing, telemetry and collision avoidance, remote identification and tagging, direct broadcast and satellite communications and landing aircraft in zero visibility.

A95-019 TITLE: Computer Aided Design System for Photonic Integration of Optoelectronic Circuits

CATEGORY: Engineering Development

OBJECTIVE: To develop a user friendly, analysis and design tool for the computer aided design (CAD) of optical circuits consisting of optoelectronic components and passive optical connecting structures. The power efficient integration of optoelectronic components is a major technology roadblock to optically controlled phased array systems for mobile and cellular communications.

DESCRIPTION: The development of a CAD system for the optical analysis and synthesis activities in designing optical paths connecting optoelectronic components would have a major impact on the development of integrated optoelectronic circuits for a wide variety of communications, signal processing, and radar applications. The control of optical modes throughout a long, complex optical path through active and passive optical components, through optical waveguide elements, and through optical

fiber segments, is critical to avoiding optical losses and spurious reflections in practical optoelectronic circuits. Computer algorithms for full wave optical propagation exist, but are too computationally intensive for iterative design procedures. Less accurate algorithms exist for matching the mode structure in optical components, but lack user interfaces which would facilitate use by circuit designers. A user friendly CAD system is needed which will permit the use of time efficient codes for optimizing the design, with computationally intensive algorithms reserved for fine tuning and final checking. The CAD system should be compatible with commonly used electronic CAD systems, with the capability of being incorporated ultimately in a combined electronic/optical CAD suite.

PHASE I: Design and analyze a CAD system for design of long, complex optical paths through integrated optical elements. Develop a graphical user interface for specifying the circuit structure.

PHASE II: Develop and test the CAD system, incorporating appropriate optical simulation and analysis tools.

POTENTIAL COMMERCIAL MARKET: Major impact on commercial optoelectronic and optical circuits, particularly for communications.

A95-020 TITLE: Near Monolithic Integration of Optoelectronic Circuits for Control of MM-wave Phased Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: To develop efficient integrated circuit designs for controlling phased array antennas, capable of low cost monolithic fabrication processes.

DESCRIPTION: Recent advances in the research of optoelectronic circuits have demonstrated the capability to control mm-wave phased antenna arrays using an optical heterodyne scheme, with dramatic potential impact on the problem of communications-on-the-move on the digitized battlefield. The integration of these circuits into nearly monolithic modules will increase efficiency and signal-to-noise ratio, decrease spurious optical reflections and vulnerability to vibration and temperature fluctuation, and reduce cost through high volume fabrication processes. In particular: fast, efficient optical detectors for moderate optical powers have been demonstrated to mix the heterodyne optical signals to produce RF and narrow linewidth DFB semiconductor lasers have been locked with phase locked loops to produce dual optical signals of moderate intensity offset by an extremely stable frequency in the mm-wave range. Proposals are solicited for the near monolithic photonic and electronic integration of these circuits for an architecture using 1300 nm or 1550 nm optical heterodyne signals over optical fiber to control antenna elements at 20-60 GHz RF. Novel techniques to minimize on-chip electrical power requirements and complexity at the detector module and to maximize the signal-to-noise ratio are encouraged. Packaging and integration of multi-chip modules should be considered.

PHASE I: Develop preliminary design of circuit. Analyze circuit for signal-to-noise, efficiency, and power issues. Demonstrate feasibility with a breadboard circuit.

PHASE II: Develop and test the integrated circuit module capable of insertion into a phased array architecture.

POTENTIAL COMMERCIAL MARKET: These modules would have direct application in commercial mobile satellite and cellular communications systems.

References:
1. PSAA-IV The Fourth Annual ARPA Symposium on Photonics Systems for Antenna Applications (1994), ARPA-TIO. Semiconductor Optoelectronic Devices, P. Bhattacharya, Prentice Hall (1994).

A95-021 TITLE: Advanced Integrated Optic Filters

CATEGORY: Exploratory Development

OBJECTIVE: To develop advanced integrated optical filters for use in high performance fiber optic communication networks.

DESCRIPTION: Integrated photonic subsystems are required for application to point-to-point fiber optic communication networks, teleconferencing, and optical control of phased-array antennas. Wavelength division multiplexing (WDM) has been proven to be an effective approach to exploit the efficient routing of tremendous information capability of optical fibers. However, efficient routing of multiple signals remains a critical issue that limits the performance of planned networks. Current routing of optical signals is accomplished through optoelectronic components that are lossy and that degrade signal to noise levels.

Fiber optic communication networks are expected to provide revolutionary improvements in information transport and processing. Wavelength division multiplexing is a proven approach for exploiting the capability of the optical fibers. With use of a limited number of optical channels, transmission rates in the order of Terabit/sec can potentially be realized without incorporation of expensive, high speed electronics. Of paramount importance for the proper utilization of such networks is the efficient routing of optical signals to different channels. Through use of multiple laser sources, it is possible to transmit multiple channels on a single fiber. However, the routing of optical signals requires cross-connecting of channels by means of an optical filter. An ideal filter would be compatible with single-mode fibers, narrowband, tunable, and low loss. Such optical filters are not presently available.

PHASE I: Demonstrate the operation of a tunable, narrowband integrated optical filter for use in single-mode optical fiber communication networks. Novel photonic devices based on the electro-optic effect or on non-linear optics are to be considered.

PHASE II: Optimize device performance of the tunable, narrowband integrated optical filter and demonstrate a low cost fabrication process compatible with modern fiber optic communication networks.

POTENTIAL COMMERCIAL MARKET: The role of optical fiber networks will be expanding rapidly in commercial sectors during the next decade. Greater information handling (data, video, voice) will be performed optically. The potential commercial market for tunable, narrowband integrated optical filters for routing of multiple signals into different channels is quite large. A low-cost, reliable process for fabricating such filters would have a significant impact on this entire technology.

References:
1. C.A. Brackett et al, "A Scalable Multiwavelength Optical Network," IEEE J. Lightwave Technology, LT-11,736(1993)
2. W.R. Trunta et al, "Acousto-Optic Tunable Filters," Opt. Lett. 18,28(1993)

A95-022 TITLE: Computer Aided Design of Printed Circuit Antenna Systems Using Suite of Optimized Algorithms

CATEGORY: Engineering Development

OBJECTIVE: To develop a fast, efficient computer aided design (CAD) system for the design of printed antenna circuits and arrays.

DESCRIPTION: An efficient, fast CAD system for printed antenna circuits would have a major impact on communications, radar, and seeker systems in the millimeter wave and SHF frequency ranges. Losses and directivity of the antenna and feed system for very high microwave frequency systems have a dominating effect on the performance and power requirements of the entire electronic system. Current EM simulation engines require large amounts of time for the analysis of practical structures. A CAD system is needed based on a suite of algorithms, each of which has been optimized for particular classes of passive circuit elements. The resulting analysis would couple segments of the EM structure to provide the overall circuit parameters. Such an analysis would be very fast and would permit rapid synthesis of antenna circuits and arrays. Such a CAD system would permit the design of antenna circuits and arrays from an "electrical circuit" point of view rather than the traditional but time consuming and complex EM point of view.

PHASE I: Develop a plan for the CAD system. Develop a graphical user interface (GUI) for a user friendly system.

PHASE II: Develop the suite of algorithms and couple them to the GUI. Develop and test the CAD system.

POTENTIAL COMMERCIAL MARKET: Significant potential impact on the design of commercial communications and radar systems.

A95-023 TITLE: Small Affordable Anti-Jam GPS Antenna (SAAGA)

CATEGORY: Exploratory Development

OBJECTIVE: Develop a GPS antenna with active anti-jamming protection, that is of the size, weight and cost magnitudes of current Fixed Radiation Pattern Antennas (FRPA).

DESCRIPTION: Currently, available GPS antennas providing anti-jam protection are not appropriate for Army platforms as they are large and costly. Under this topic, advanced microelectronic circuit and processor technology shall be applied to develop a GPS antenna that is equivalent in size, weight and cost as FRPA's and has anti-jamming performance as effective as Controlled Radiation Pattern Antennas. This program shall consider both broad and narrow band jammers. Adaptive techniques

shall be investigated to null jammers based on feedback from a GPS receiver via digital interface. Applications to be considered include all Army platforms (soldiers, ground vehicles, helicopter and fixed wing aircraft).

PHASE I: Design an active anti-jam antenna in the size and cost magnitudes of a conventional FRPA GPS antennas.

PHASE II: Build and demonstrate the antenna and associated electronics. For this phase, a brassboard prototype is acceptable. The contractor will present a plan for miniaturization and design-to-cost. The Government will conduct a demonstration of the brassboard system in the lab and on an aircraft.

Phase III: Under this phase, the contractor will package the antenna and associated electronics in a production configuration. The government will undergo a full qualification program of the antenna.

POTENTIAL COMMERCIAL MARKET: GPS is emerging as a major positioning and navigation system for commercial aircraft (enroute and landing), maritime navigation, trucking, surveying and recreational purposes. Coincidental interference (for example from cellular telephones) and intentional jamming (terrorist) is perceived to become a problem as the civil sector develops its dependency on GPS. Technology resulting from this program can be applied to reduce the effects of interference and jamming in a cost effective manner.

A95-024 TITLE: Complementary High Power RF FET Development for High Efficiency Amplifiers

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabricate a pair of complementary Field Effect transistors (FET), N-channel and P-channel, capable of switching at frequencies sufficient to provide switched mode amplification of frequencies up to 1Ghz, and delivering 250 to 300 Watts of RF power.

DESCRIPTION: Army EW systems have limited prime power reserves due to their mobility requirements. Current transmitting systems are inefficient, usually averaging less than twenty percent efficiency. There exists several amplifier topologies that can achieve greater than eighty percent efficiency, these are the switched mode amplifiers such as Class D and E. Current transistor technology is focused on linear amplification applications, this limits the useful frequency range when used in switched mode amplifiers. A potential solution is the creation of devices specifically designed for switched mode applications. The transistors will be designed specifically for switched mode high efficiency amplifier topologies such as Classes D, E and S. Linear operation of the devices is considered irrelevant. The goal will be devices capable of delivering 250 to 300 Watts of RF power in a Class D push-pull configuration. FETs are the device of choice because of their high input impedance and ability to conduct current in both directions. The material used in the design is not specified, however, both the material and the processing required must be commercially available. This effort shall improve the efficiency of EW systems by positively impacting the system power requirements, system size and weight.

PHASE I: The contractor shall investigate designs for the devices that may satisfy the objective. The potential device designs shall be simulated using programs like SUPREM and PISCES. A final report will be generated presenting the most favorable designs indicating the strengths and weaknesses of each approach and any technological barriers that may hinder fabrication.

PHASE II: The contractor shall fabricate and test the best design(s) for the new device. The program may be segmented by fabricating lower power test versions. For example the first devices may only be rated at 50 watts, followed by a 100 watt version, and finally a version that meets the requirements of providing greater than 250 watts of RF power. The programs segmentation is to reduce risk both technically and financially. Deliverables shall be transistors developed, test data, design data, simulation results, test amplifier, and a final technical report.

POTENTIAL COMMERCIAL MARKET: There is a large market within the EW community for high efficiency broadband amplifiers. Commercial possibilities would be in commercial broadcasting, instrumentation amplifiers and the exploding telecommunications industry.

A95-025 TITLE: Conformal Antennas for Soldier C4I

CATEGORY: Exploratory Development

OBJECTIVE: Develop low power, high data rate, omni-directional C4I for the individual soldier.

DESCRIPTION: A need exists for wide-band, high data rate communications capabilities for the soldier in the field. A wireless LAN solution that does not require directional antenna pointing for the soldier on the move is desired. Conformal antenna

technology embedded in the soldier ensemble can solve the problem and also provide a relay capability for soldier paging and reporting.

PHASE I: Will conduct research and investigate and propose solutions for the development of an individual paging and limited messaging capability without resort to highly jammable satellite transmission. Maintaining suitable antenna gain for a moving individual in omni-directional and various skeletal attitudes is a major technical barrier to this realization. The initial investigation will establish minimum gain ratios a function of activity and body orientation that is consistent for low rate data exchange and less than 10 M/W power consumption for portable systems.

PHASE II: Refine the recommended solution and proceed with advanced development of prototypes.

POTENTIAL COMMERCIAL MARKET: Commercial applications include high data rate multi-media uses for personal digital assistance in areas of visual teleconferences, travel mapping, way point/best route prediction and personal tracking and safety. Dual use of this technology would also include use by forest rangers/fire fighters, riot peace keepers, police and drug enforcement agencies and border patrol. A soldier walking through the woods on patrol, a launch crew or a vehicle crewman would benefit from the omni-directional capability.

A95-026 TITLE: Advanced Hermetic Metal Coated Optical Fibers for Precision Alignment for Optical Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop in line processing of magnetic coated optical fiber that will allow for an optical-fiber package precision wound on a reel-out bobbin to maintain a small-free standing stable package in tethered vehicle which is of special importance in military defense systems. The bobbin maintains the convolution in a precision wound package to prevent snags during payout. A magnetic coating on an optical fiber insures that the fiber is held in the proper position during winding. This provides a constant force to support the fiber during storage and a constant peel force during deployment.

DESCRIPTION: Typically, a conventional fiber is held in its precision wound spooled state by means of a sticky organic adhesive. This adhesive can cause mechanical fatigue to a precision wound fiber bobbin which can cause degradation of the optical fiber and even cause physical failure of the fiber during deployment. Magnetic coatings on optical fibers have the potential to eliminate many of the severe deficiencies of an organic adhesive system. Such problems as non uniform peel-out rates due to viscosity changes, fiber strength degradation, organic plastic deformation, "fishing snags" (fiber knotting or kinking) and environmental effects can be minimized by the use of magnetic coated optical fiber. Magnetic coating on optical fiber can also lead to faster fabrication of spools, which is presently a costly drawback when using organic adhesives. Magnetic coatings provide a hermetic, high strength magnetic fiber which eliminates the common problem of an adhesive-based system and will provide a practical and also a cost effective means of producing a reliable, fast payout spool.

Deployment of optical fiber on payout spools on moving air, land, water craft has been utilized as a means to establish a fast communication link. This technique can be use for a variety of military and commercial applications. This has been particularly useful in rapid missile payout systems (e.g. Non-Line -Of-Sight Arms Weapon -NLOSCA) where optical fiber is spooled out at a very high rate of speed from a missile. Optical fiber is physically connected to the missile during its flight to provided a bi-directional tap-proof communications link to exchange critical guidance and intelligence information between the ground station and the missile.

This approach will use a thin film ferromagnetic metal coating on the fiber. There are several approaches to using magnetics to cohesively bundle such coated fiber into a sturdy skein, each taking advantage of the wide range of magnetic properties. Advanced magnetics offer an opportunity for enhanced performance and novel application of optical fibers. These coatings can potentially help in storage, self-life and deployment as well as overall reliability of optical fibers for military applications.

This advanced technology will also have outstanding potential for generation of micro or milliwatt power for micro-opto electronic devices. Magneto-optics relates the influence of magnetic fields on optical properties of light, magneto -optics is characterized by electromotive force developed by magnetic means for dual purpose generation of micro power (milliwatts) and modulation of light via electromotive force on optical fiber light for wavelengths 1.3-1.5 microns for photonics and opto-electronic devices.

Additionally these coatings can lead to several other applications. The property of the magnetic coatings has application for systems requiring precision alignment via magnetic attraction of fiber to metal ferrule sleeves such as optical connectors. It also has application to the production of novel electro-optic and related devices and subsystems.

PHASE I: In Phase I, a thorough exploratory investigation and implementation of a magnetic coating on optical fiber will be conducted. This can include, but not be restricted to, the following: initial sample of a magnetic coated fiber, magnetic properties of magnetic coated fiber with respect to properties pertinent to precision alignment, production on a magnetic coated

optical fiber bobbin, analysis of the spooling mechanism using magnetic coatings, feasibility, and final analysis and recommendations. Magnetic coated optical fiber will be characterized for their magnetic and optical properties.

PHASE II: In Phase II, a continued analysis based on Phase I conclusions will be performed. This will include implementation of improvements to the magnetic coated optical fiber payout system, analysis on actual payout bobbins, preliminary analysis of payout using magnetic coated optical fiber, actual payout testing and final analysis and conclusions related to commercial feasibility.

POTENTIAL COMMERCIAL MARKET: This magnetic coated optical fiber will have potential uses in magneto-optic disk head technologies, data storage, and novel magneto-optic transistors. Magnetic coated optical fiber also has the ability to generate electrical current when exposed to high magnetic fields. This property will result in various lightweight motors and generators commercial applications. Also space based applications and sensor technology use are anticipated. Magnetic coating of optical fiber and analysis of spooling mechanisms has potential commercial application in areas where high strength fiber and a cost effective means of fast payout is needed such as in commercial, recreational equipment fishing and research as well as other areas.

A95-027 TITLE: Phase Locking of Semiconductor Lasers for Optical Generation of Millimeter Wave Sources Greater than 60 GHz

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to investigate means for optical coherent heterodyning to create microwave signals for use in wideband analog transmission and phased array antenna systems. This will require demonstration of, but not be restricted to, the following: phase locking of semiconductor distributed feedback lasers with a stable upconverted frequency range greater than 60 GHz; utilizing lasers with orthogonal polarizations to allow for transmission over optical fibers prior to heterodyning or alternative techniques; external modulation of one of the lasers; and maintaining polarization separation during fiber optic transmission. Semiconductor lasers also make it more viable to integrated in a monolithic package. The overall goal is to monolithically integrate these optical elements in a single device. This would provide a lightweight, low cost, robust, technically superior optical system for the generation of microwave/millimeter wave energy.

DESCRIPTION: CECOM is developing technology leading to the demonstration of optically controlled phased array communications sub-systems for Army communications on-the-move (OTM). Carriers frequencies might vary from 6 to 60 GHz with data rates of 2.4 Kb/s to 155 Mb/s or more. Adaptive multiple antenna beams and adaptive null capabilities will ultimately be required. Major emphasis is being placed on a high degree of photonic integration to develop modular, scaleable and "frequency independent" subsystems for multiple applications and to reduce size, weight and cost, thus leading to a practical realization for Army tactical systems. Near term emphasis is on optical phase control. The systems support the Army initiative to "digitize the battlefield." CECOM has already initiated Research & Development contracts in support of some aspects of these sub-systems.

PHASE I: I Phase I, a thorough exploratory investigation and modeling will be conducted to experimentally verify the feasibility of the objective. This will include, but not be restricted to, the following: phase locking techniques for optical heterodyning, design of control circuitry for phased locking scheme, linewidth requirements, system requirements, polarization issues, modeling and design in support of coherent optical communication, and experimental verification. A thorough investigation of Distributed Feedback parameters will be conducted to determine fundamental limits of phase and frequency.

PHASE II: In Phase II, a continued analysis based on Phase I conclusions will be performed. This will include implementation of an optical heterodyning system leading from discrete optical devices to a highly integrated photonic device. An end result would be the incorporation in a prototype phased array antenna system, and a fielded demonstration of prototype system.

POTENTIAL COMMERCIAL MARKET: This concept will have potential uses in long haul communications systems, satellite applications. Applications include both SATCOM OTM (on-the-move ground terminals) and terrestrial communications OTM.

A95-028 TITLE: Thin Film Semiconductor Placement on Host Substrates

CATEGORY: Exploratory Development

OBJECTIVE: To develop processes, materials, and equipment that allow high-speed, automated placement of thin-film

semiconductor devices onto integrated circuit and multichip module (MCM) substrates.

DESCRIPTION: Recent developments have led to the capability of separating an epitaxially grown semiconductor device from its substrate while retaining the electrical characteristics of the device. This process, known as epitaxial lift -off (ELO), allows the combination of different semiconductor material systems when the lifted-off device is transferred to a host substrate that can be of difference composition than the growth substrate. With this technique, compound III-V semiconductors (such as GaAs) can be grown in a process optimized for the particular material, while electronic processing circuitry can be created in a process optimized for its material system (such as Complementary Metal Oxide Semiconductor (CMOS) silicon). The materials are brought together only after the material/device growth is complete, thus allowing hybridization at a semiconductor device/integrated circuit level. What is needed is a precise, automated method of transferring thin film semiconductor devices/circuits that have been "lifted off" onto the host substrates.

PHASE I: Examine material combinations and processes for transfer of thin film semiconductor ELO devices from a carrier to an integrated circuit substrate. Determine best release mechanism for the device to be released from the carrier (mechanical, thermal, ultrasonic, etc.) Examine feasibility of placing thin film devices onto or into a "smart" multichip module substrate. Investigate potential for automated device testing following placement. Develop a system concept document describing an automated machine that can deposit 30 devices/minute or 10 circuits/minute onto a host substrate, with 5 micron resolution and 1 micron repeatability. Include considerations for clean room environment, cost of equipment, modularity, and adaptation of currently available systems or systems under development.

PHASE II: Design and fabricate a prototype placement machine based on the system concept developed in Phase I. Develop all software, machine vision, and CAD interfaces needed to perform system functions and interface with one human operator. Test prototype system on multiple runs of different ELO devices and substrates. Benchmark system to determine capabilities/limitations, and investigate opportunities for improved performance and lower system cost. Canvass industry for potential beta test sites.

POTENTIAL COMMERCIAL MARKET: The equipment developed under this SBIR would be an enabling technology for the availability of high performance integrated circuits and MCMs. The market for MCMs is expected to increase at least 10-fold by the end of the decade. The increased functionality to individual integrated circuits will allow compact packaging of military, commercial, and consumer products with more capabilities at lower cost.

A95-029 TITLE: High Efficiency Input/Output Couplers for Optical Waveguide Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop high efficiency optical couplers for guided wave photonic devices and optical integrated circuits (OICs)

DESCRIPTION: For many applications such as optical gyroscopes, TR modules and high density signal processing very high efficiency, low cost couplers are required. Differences in mode profiles, index matching and applications requiring out of plane coupling between optical fibers, semiconductor waveguides or new material systems such as electro-optical polymers make the problem more difficult. The key desirable features are low loss <1dB), versatility in processing for application to hybrid systems (particularly semiconductors and polymers), low cost, compact size, and adaptability for either spatially distributed or single mode coupling.

PHASE I: Design and demonstrate basic concept for new optical coupler techniques. Evaluate performance and analysis results for comparison to conventional techniques. Semiconductors and EO polymers should be particularly considered in the wavelength range of 0.8 -0.9 and 1.3 - 1.5 microns.

PHASE II: Optimize coupler design for selected application specifications and demonstrate technique. Analyze and compare tradeoffs for performance, material systems, and architecture.

POTENTIAL COMMERCIAL MARKET: A wide range of commercial applications are currently being developed for optical gyroscopes, biosensors, multichip modules for computer interconnects, T/R modules for communications links, and fiber links for video networks. In all of these application performance, cost, and size are critical issues which are in large measure driven by capability of electro optical system components coupled together with optical fibers. Improvements in coupling technology, particularly for hybrid system will greatly impact near term insertion into these commercial markets. In many cases the coupling technology will make the difference in the ability to use a particular optical material or electro optical component in these systems.

A95-030 TITLE: Agile Laser Protection for Combat Vehicle Surveillance Vision Devices

CATEGORY: Exploratory Development

OBJECTIVE: To develop agile laser protection technologies for surveillance vision devices. These protection technologies must reject harmful laser radiation, independent of its wavelength, while allowing low energy scene illumination to pass through to the eye.

DESCRIPTION: The U.S. Army, Navy, Air Force, and Marine Corps consider the protection of the eyes of military personnel against laser radiation to be a priority objective. The human eye is most susceptible to laser radiation in the range of wavelengths from 400 to 1400 nanometers and must be protected throughout this region. The non-visible portion of this spectral range should be denied access to the eye by fixed attenuation. Transmittance in the region from 400 to 700 nanometers must be preserved to maintain vision under all conditions and illumination. Increasing the number or width of fixed attenuation bands in the visible spectrum will result in unacceptable degradation of the transmittance of visible light through the protective material. New concepts are therefore required. The effort sought in this solicitation is for new technological approaches to protect the eyes of combat vehicle crews, when using unity vision equipment, against emerging multi-wavelength and frequency-agile lasers. The basic desired attributes of the non-linear laser power limiting material/system include: capable of meeting minimum optical density requirements regardless of the angle of incidence of the laser radiation; response time for activation of attenuation of less than one nanosecond; recovery time from attenuating condition of less than 0.1 second; visual transmittance, both photopic and scotopic, of at least 50%; capable of resisting laser damage; and capable of functioning in temperature extremes (-40 Deg to 160 Deg F) and humidity extremes (0% to 100% RH).

PHASE I: The contractor shall investigate, design and provide a proof-of-principal demonstration of a novel agile laser protection technology meeting the requirements set forth in the project description. A final report shall be delivered.

PHASE II: The contractor shall fabricate, test, demonstrate, and deliver the protection approach developed in Phase I. A final report shall also be delivered.

POTENTIAL COMMERCIAL MARKET: Laser protection has enormous commercial applications for safety and health equipment due to the proliferation of lasers in laboratories, academia, and industry. Examples include protection for industrial machining activities, medical procedures, communications, and computing.

A95-031 TITLE: Affordable Scanning Millimeter-Wave (mmW) Antenna Technology

CATEGORY: Advanced Development

OBJECTIVE: The Army has an inherent need to develop enabling radar technology that is both affordable and flexible with growth potential to address many radar requirements. An area that best demonstrates a need for both affordable and flexible technology is in the antenna assembly. Too many antenna technologies are limited to a specific operating band or use expensive components for scanning, transmitting, and receiving or have a heavy, bulky structure. Specifically we are looking for a planar antenna design that has a separate transmit and receive capability, a center frequency between 33 and 35 GHz with a technology growth potential to operate at higher frequencies (i.e. W band), a 2 GHz bandwidth, a narrow beam of less than 2 degrees that is vertically polarized. We desire scan capabilities of plus or minus 30 degrees at a 60 degree per second scan speed and a scan width that doesn't change with frequency. We also desire sidelobe levels that are greater than 20 dB, loses that are less than 2 dB and Voltage Standing Wave Ratio (VSWR) that is less than 1.5:1.

DESCRIPTION: An antenna is required to support the various missions associated with a target acquisition radar. These missions include moving and stationary target indication which suggest low antenna losses, a modest gain, a narrow beam, wideband operation, and polarimetrics.

PHASE I: This effort should study the various antenna technologies that can support the above specifications, emphasizing technology tradeoffs with respect to affordable and flexible architectures. There should be considerable reasoning in the selection of one antenna architecture over another. Identify areas of risk associated with the chosen architecture. Simulate and develop a preliminary design and describe the flexible features and upgrade path for this antenna structure. There should also be a cost breakdown for prototyping one antenna assembly for a Phase II effort as well as for a production cost for 1000 units.

PHASE II: Simulate, design, build, test and report on the chosen antenna structure from the Phase I.

POTENTIAL COMMERCIAL MARKET: An antenna structure that is both affordable and flexible and is associated with supporting radar technology may have vast commercial opportunities i.e. collision avoidance in the automobile industry.

A95-032 TITLE: Artificial Intelligence Enhanced Information Processing

CATEGORY: Basic Research

OBJECTIVE: This topic solicits research in advanced information processing algorithms as well as hardware architectures which will support critical Army program areas such as fusion stations, ground stations, advanced sensor based robotics, and automated target recognition.

DESCRIPTION: The Army has a strong continuing interest in real-time information processing research as applied to single sensor, multi-sensor, and multi-sensor integration (fusion) station processing. Information processing includes those operations normally performed after signal processing, thus relating to higher levels of abstraction and lower "bandwidth" (measured in instructions per second) than those addressed by signal processing. Examples of information processing tasks include multi-sensor correlation, fusion, target tracking, situation assessment, target value analysis, etc. Information processing encompasses approaches that are both algorithmic and symbolic (based on artificial intelligence (AI)). Applicable research topics should relate to high-speed signal and information processing (particularly with AI based enhancement) for such systems as acoustic, radar, and electro-optic sensors in a single and multiple (homogeneous as well as heterogeneous) sensor configurations. This topic includes advanced processing architectures as well as advanced algorithms.

PHASE I: Information processing research yielding innovative algorithms or advanced processing architectures which are then simulated or otherwise shown to have potential in real-time processing applications.

PHASE II: Research resulting in the real-time implementation of Phase I algorithms and/or processing architectures which will show direct relevance to an objective interest area such as fusion stations, ground stations, advanced sensor-based robotics.

POTENTIAL COMMERCIAL MARKET: The technologies related to this topic, Artificial Intelligence Enhanced Information Processing, correspond strongly with a number of commercial or dual-use applications such as aircraft tracking and control for commercial airfields, intruder detection and tracking, manufacturing inspection, and intelligent highway system applications.

A95-033 TITLE: Intelligent Information Presentation for a Helmet Mounted Display in a Synthetic Environment

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative and intelligent information presentation for a Helmet Mount Display (HMD) as aircraft flight regimes change.

DESCRIPTION: Future methods of providing appropriate and timely information to the rotorcraft pilot via an HMD will require significant improvements to meet mission and pilotage requirements. Categories of information already envisioned for the HMD display include flight, navigation, system, obstacle avoidance, virtual switching and warnings, and weapons status, and target acquisition. Research has shown that this volume of data leads to pilot information overload. Advances in intelligent information presentation as well as prioritization and filtering of flight mode information needs to be achieved to obtain an essential high level of performance during low altitude night operations. As the rotorcraft movers through flight modes such as hover, lowspeed flight, cruise, and maneuver the symbologies displayed should intelligently and automatically make the same timely information transitions. Manual mode selection of display information in use today was developed in the late 1970s. Manual mode selection does not take advantage of data bus and electronic cockpit monitoring systems that could provide automatic and intelligent information updates. Manual mode switching increases pilot workload and often results in unnecessary display icons that clutter the pilot's synthetic environment. Current technology does not provide the intelligent information presentation requirements necessary in future aircraft. Reduced pilot workload, safer flight envelopes, the encouragement of low-cost HMD development and use in the civil sector, and simpler pilot-vehicle interface with reduced switchology are all goals of this program.

PHASE I: Using several design principles for information display, identify and evaluate innovative flight and mission information mode switching concepts necessary for representative aviation mission. Then, using a baseline which is representative of current technology, select several candidate intelligent information prioritization/filtering techniques to demonstrate the potential increase in pilotage and mission effectiveness.

PHASE II: Preliminary evaluations of intelligent information presentation concepts for an HMD will be performed in both ground and in-flight simulation to verify improvement potential. Complete definition of intelligent moding characteristics

of the most promising configuration will be verified in flight tests on helicopters with HMD systems.

POTENTIAL COMMERCIAL MARKET: This automatic moding HMD technology will have multiple applications in civil sectors in areas of emergency services including police, ambulance, forestry, and fire protection. Civilian resources are increasingly being tasked to monitor and assist in border surveillance, neighborhood surveillance, fire emergencies, highway patrols, forest protection, police reinforcement, and rescue service. Rotorcraft play a unique role meeting the civilian sector needs in all of these areas. These activities represent a growing market for rotorcraft; especially, in high population density areas. It is these high density areas where safety of flight issues are magnified and where intelligent flight moding will be most useful.

A95-034 TITLE: Acoustical Sensor, Target Engagement, Environment And Performance Model

CATEGORY: Exploratory Development

OBJECTIVE: Methods are currently under development to increase survivability of friendly forces through the use of non-cooperative passive acoustical identification technologies. The objective of this task is to design, develop and implement an acoustical target, environment and sensor simulation model in order to investigate and quantify acoustic sensor performance under a variety of controlled and repeatable conditions.

DESCRIPTION: Non-Cooperative acoustics has especially high potential for assisting the army in the difficult problem of passive detection, classification and identification of various targets. Acoustics does have its limitations. Accurately modeling and estimating performance of these sensors is complex. Propagation of all acoustic signals are sensitive to atmospheric, meteorological and terrain variabilities. This is especially true in the case of the acoustic signatures of many types of targets of military interest. The problem to be explored poses several important technical challenges, among them: 1) Target signatures are inherently broad band and highly variable, 2) Acoustic propagation through the atmosphere and interaction with the earth's surface can greatly alter target signatures, and 3) Acoustical sensors may employ a variety of signal processing techniques as well as sensor configurations. These factors and others tend to complicate the analysis of acoustic sensor performance via traditional analytical methods. The output of this model will be a spectrum of figures of merit.

PHASE I: The contractor shall review and quantify all factors affecting acoustic emanation, propagation and detection. The contractor shall then make a determination of the factors to be modeled in this effort. The contractor shall also develop the system architecture concept and perform analyses, trade-offs and other analytical studies on the various factors. These should include but not be limited to engagement factors (i.e. Platform and trajectory data, initial conditions, interference sources placement and qualities, terrain data(digital), and discrete objects), Propagation factors (i.e. Terrain, Multipath, Obscurants, atmosphere, meteorology etc.), and Sensor Information (i.e. sensor geometry, number, placement, characteristics and signal processing). In addition, the initial output figures of merit shall be developed and refined.

PHASE II: Implement the model using a modular approach, in order to provide statistically meaningful data with the various figures of merit developed. Test the discrete modules and the integrated system to verify adherence to theoretical and benchmark predictions (e.g. simulator laboratory testing). Exercise the system using realistic engagement scenarios. The Model will be used to calculate and output measures of performance for specific engagement scenarios of interest to the Government.

POTENTIAL COMMERCIAL MARKET: This model would have application to the commercial aviation industry, and to the FAA for studying airport noise levels in its ability to estimate noise levels under a given set of circumstances. It can also provide noise estimates to the transportation industry to assess noise related environmental impacts of highway construction and expansion.

A95-035 TITLE: Soldier-Computer Interaction/Communications

CATEGORY: Exploratory Development

OBJECTIVE: Define methods and technology to address the total soldier-computer interface.

DESCRIPTION: Consistency and quality of the soldier/computer interface in a variety of operational scenarios is a must. To effectively communicate with emerging automation soldier comfort and assimilation must be maximized to minimize errors. To exploit the increased competence of the modern soldier and the power of automation, boredom, stress and fatigue along with specialized training needs to be reduced. A wide range of real time interaction is needed from the highly structured environment of the soldier in the fire fight world to the interface requirements of the various command post echelons.

PHASE I: Evaluate, select, and test current and evolving hands free technologies useful for man machine interface.

PHASE II: Refine the recommended solution(s) and proceed with advanced development. Integrate and assemble candidate technologies into a prototype and conduct live soldier tests to evaluate performance.

POTENTIAL COMMERCIAL MARKET: High potential for virtual reality and hands free interaction with computers in entertainment and commercial vehicle operations. Dual use applications in many manufacturing and real-time vehicle control situations (buses, aircraft, ships/ferries, trains, subway systems, etc.) that would benefit from a more natural presentation of multimedia data. Multimedia presentations include the simultaneous interaction of the human to live video, data, status, communications and controls elements. Special consideration is given to the technologies that can support multiple human status/well-being measurement and display with overlaid computer decision support presentation to reduce the investigator workload. The combination of technologies will be coupled in a cognitive manner to reduce the amount of superfluous and redundant information to ease the human interaction with computers/communications equipment.

A95-036 TITLE: The Detection and Location of Buried Metallic and Nonmetallic Targets

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the feasibility to detect shallow buried objects such as landmines.

DESCRIPTION: The desire is to detect and locate buried objects such as landmines. These objects are usually no more than 6 inches deep. The object may be metallic or nonmetallic and range in size from tennis ball size to 12 inches in diameter by 4 inches thick. There are no restrictions on the detection phenomenology. An experimental demonstration component of any proposal is desired. The detector may be man portable, vehicle mounted or airborne.

PHASE I: This phase should include thorough analyses that theoretically demonstrate the scientific soundness of the phenomenology to detect the objects of interest as well as related and supporting experimental or laboratory results.

PHASE II: This phase should emphasize field experiments and demonstrations designed to clearly establish the feasibility of the phenomenology to detect buried landmines in real soil and terrain conditions in the field. The proposal should also accommodate participation in blind field tests run by the government.

POTENTIAL COMMERCIAL MARKET: Mine detection technologies have broad applicability to other applications including road inspection, utility line and pipe detection, environmental remediatory hazardous waste detection, bare cleanup, and nondestructive testing.

A95-037 TITLE: Miniature Multiple Sensor For Remote Surveillance

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a small, lightweight, low power requirement multiple sensor package to enhance remote detection.

DESCRIPTION: Current remote surveillance sensors are typically packaged individually. If single sensors suites are employed, a knowledgeable forces can often defeat surveillance. To meet a variety of conditions and to preclude stealth attacks, a number of different sensors must be employed. The need for multiple ruggedized physical packaging and multiple power sources and transmission circuits increases the system weight, size, and cost. These limitations result in less convenient field usage. What is needed is a whole new class of integrated sensors suites with small unit coverages out to one kilometer and operating for several days on a small battery (or other power source). Cost should be low enough that sensors can be abandoned if need be.

PHASE I: Investigate the available and developmental state-of-the-art in overlapping sensors in the acoustic, radar, infrared, and optical portions of the spectrum. Project current state of development for several years into the future (probably production development time). Define the tradeoffs in power, coverage, sensitivity, size, security features, low detection probability, extrapolated cost, range, ruggedability and packaging, and so forth. Use modelling to select several configurations representing nominal optimization for several deployment situations.

PHASE II: The Army will select one of the configurations defined in the first phase for prototype development and demonstration. The contractor may elect to use REMBASS as the base system or use one of their own design.

POTENTIAL COMMERCIAL MARKET: Security surveillance systems are needed for almost all installations. These include nuclear plants, storage yards, warehouses, port facilities, prisons, governments buildings, olympic sites, and many, many more. Such are the times in which we live.

A95-038 TITLE: Development of Real Time Ray Tracing Software

CATEGORY: Exploratory Development

OBJECTIVE: To create a fast, high power, computational tool that can provide the high resolution, complex scene geometry input necessary to drive FLIR sensor simulations. This tool, when installed on a powerful, modern, computer and applied to a highly detailed battlefield geometry model, will make it possible to generate truly realistic, electronic battlefield imagery as viewed through an existing or future design IR sensor.

DESCRIPTION: To construct an efficient, high resolution, ray trace imaging tool that can accept highly detailed complex geometry as input and produce real time results on a massively parallel computer. Complex geometry databases include terrain maps, trucks, tanks, buildings, trees (with leaves), roads, grass, etc. This tool should employ an algorithm that is easily run on multi-CPU machines having a UNIX operating system. This tool should be written in the C programming language.

Current technology employs polygon rendering algorithms with texture maps. Although this approach is fast (especially when combined with high speed polygon rendering hardware), it does not efficiently handle optical effects such as shadowing, semi-transparency, and diffusivity. Polygons are great for modeling large flat structures; however, complex surfaces such as aircraft fuselages, Russian tank turrets, boat hulls, and terrain cannot be accurately modeled using polygons. The problem with these complex surfaces is that they have no flat areas and the number of polygons required to preserve their curvature is very large. It is the sheer number of polygons required that cause polygon based codes to slow down excessively or exceed software array boundaries.

The best illustration of this is a soccer ball vs. a sphere. If the patches on the surface of the soccer ball were flat, the ball would not roll perfectly on a flat surface. The sphere does not have any flat patches and therefore rolls perfectly. As the number of flat patches on the soccer ball is increased, the soccer ball approaches the sphere in behavior. If the number of patches is infinite, then the soccer ball becomes a perfect sphere.

PHASE I: Investigate combinatorial solid geometry (CSG) raytracing techniques to locate the best current algorithms and methodologies. Evaluate to determine any bottlenecks, scaling factors, distributed processing capabilities, and portability issues exist. Scaling involves any database complexity vs. performance coupling. Distribution involves how well does the algorithm vectorize and/or distribute across multiple processors and CPUs. Once the investigation is complete, formulate a methodology for testing new methods and algorithms. Establish a common metric, posing questions such as will it raytrace this? and How long will it take to raytrace this?. Formulate an approach for achieving the objective and complete Phase I by delivering a report describing the results of the above.

PHASE II: Implementation of the Phase I results to develop a prototype ray tracing tool. Algorithms will be implemented by either the creation of new code or the proper usage of existing code that meets specifications. Once implemented, each algorithm will be subjected to a rigorous test and evaluation suite. Once assembled, the overall ray trace tool will be subjected to the evaluation methodology developed in Phase I. The overall goals are: 1) Distribution of the rendering problem over more than 100 CPUs (dissimilar manufacturer running UNIX) with a minimum efficiency of 98%, 2) Rendering of a 10 kilometer X 10 kilometer terrain with approximately 50,000 trees, 100 high resolution vehicles, and 5,000 detail items (such as 'houses, roads, fences, telephone poles), and 3) Rendering the above images 'at 640X480X24 bits (full color) at 5 hertz. The entire model will contain 'approximately 20,000,000 solids.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for this real time ray tracing software is anyone that requires much higher detailed computer generated imagery of complex geometric models than is currently available. These fields include film making, scientific visualization, FAA studies, motion simulators (ground and air), construction planning, interior design, and antenna placement.

A95-039 TITLE: Super High Frequency (SHF) Tri-Band (C.Ku. and X) Antenna Feed for Satellite Communications Terminal

CATEGORY: Engineering Development

OBJECTIVE: Develop and demonstrate a new and innovative approach for Multi- band Satellite antenna feed systems. The feed system to be developed will cover the commercial Satellite Communications Bands C and Ku. as well as the military DSCS X-Band.

DESCRIPTION: The trend in the military is to utilize commercial Satellite Communications (Satcom) to augment military

Satcom. Current systems utilize three or more separate feeds to that would be physically connected to the antenna, one at a time, for this application. A tri-band feed would allow the user to change from one satellite frequency to another without a manual change to the antenna configuration. This tri-band feed would also be expected to reduce the weight of the system. The weight is important to tactical systems which have severe weight restrictions due to the host vehicle.

PHASE I: Investigate new and innovative methods for combining the three frequencies onto a one feed system. Modeling and analytical evaluation shall be used to predict the performance of the feed across all frequency bands. Mechanical analysis shall be performed to determine the raggedness of the feed system in a tactical environment.

PHASE II: The concepts developed in Phase I shall be implemented into an engineering design and prototype development. The Feed shall be tested on an antenna chosen by the contractor. Detailed design drawings and specifications shall be developed.

POTENTIAL COMMERCIAL MARKET: The technology developed would have direct application to the commercial Satcom market. Two of the three frequency used are commercial Satcom frequencies. Weight savings for commercial Satcom is an issue as in military Satcom.

A95-040 TITLE: Advanced Common Digital Hardware for Intelligence Electronic Warfare (IEW) Systems

CATEGORY: Exploratory Development

OBJECTIVE: Current Communications ESM/ECM systems are required to be high performance which tends to increase costs, both production and operational and support (O&S). In addition the number of systems is relatively small, thus the ability of large scale production to reduce costs is limited. Advantage may be taken of the fact that ESM/ECM systems are essentially totally digital hardware. However presently the systems are composed of multiple types of different digital technology: specialized signal processors; general purpose or fast personal computers; signal analysis workstations; and waveform generators using digital processors. The highly parallel architecture as now used allows consideration of a system composed of common digital processing components for almost all functions. Although common digital processors may be more expensive than any one component now used, the large number, even in low density equipment field applications, of the same component can reduce production costs and O&S costs. These components (as line replaceable items or circuit card assemblies) must be stocked as spares and configuration managed separately. Operational and Support (O&S) costs are driven by the number of different items that must be maintained in the inventory.

DESCRIPTION: The common processor must account for the high data processing speeds needed for high dynamic range, signal acquisition/analysis in milliseconds in dense environments and real time multiple signal ECM response which can also be created digital. This may be accomplished with common processors through the use of innovative algorithms, special application chips, host common, lower performance, processors or a combination of approaches. A significant hardware architecture challenge is the extensiveness of hardware commonality achievable between the signal analysis kinds of functions, the data processing functions, display generation functions, and the jamming control/ waveform synthesizer functions. These functions are at different speeds and have different input output forms of signals (e.g., analog to digital, digital to digital, digital to analog). Objective is to have common components, e.g., microprocessors, DSP chips, et al, which reduces first time costs and some spares cost but a more important objective is to group these common components into as few LRUs, e.g., printed circuit boards, as economically and maintenance possible or these are the stews forming the system and are the major costs in first time fabrications and in O&S costs. This requires the same or very similar PCB's to do signal processing, data processing, and waveform generations through possibly an arrangement of inputs/outputs, data bus protocols to reduce inter connectors, and possibly latent code and connectors, exercised only when needed.

PHASE I: This will be trade-offs of various candidate architectures, simulations of the response of these architectures for performance estimates of resulting cost reductions to be achieved. Key issues are ways to handle both low and high speed functions, input and output translations, data bus and signal path optimization and producibility/costs per processor/function. Driving point functions and their sensitivity must be identified. A final technical report will describe in detail the results.

PHASE II: A single real time operating breadboard thread of the selected architecture and components will be assembled to verify performance and better refine costs reduction estimates. The deliverables would be the architectural design of a system based on the breadboard and a final technical report.

POTENTIAL COMMERCIAL MARKET: The DSP architectures and hardware developed for this project will have a very large number of multidimensional processing problem applications in data processing, imaging and medical instrumentation. In addition this concept has application to radio transceivers of all types, including satellite communications and radio data handling networks.

A95-041 TITLE: Synthetic Aperture Techniques for Radar Resolution Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: A millimeterwave radar is currently being developed by the Army to provide the tank commander with an all-weather target acquisition capability. A radar sensor is needed to penetrate atmospheric obscurants such as rain, fog and smoke that limit the performance of Electro-optics and Infrared sensors. Synthetic Aperture techniques are generally well understood by the radar community but these techniques are not currently being employed in low-cost designs. The objective of this research project is to investigate the use of affordable Synthetic Aperture Radar (SAR) and inverse Synthetic Aperture Radar (ISAR) techniques to improve stationary and moving target classification and fire control performance.

DESCRIPTION: The approach of the current development program is to demonstrate an affordable Moving Target Indication (MTI) radar. The MTI radar will function as a target acquisition sensor and will hand off target detections to the FLIR sensor for accurate fire control. A Ka-band (35 GHz) solution was selected for the following reasons. Milliter wave-length radar is required to keep the size of the antenna aperture reasonably small. Within the millimeter wavelengths, atmospheric absorption limits detection range outside of the Ka and W frequency bands. Ka band has superior range performance in conditions of moderate to heavy rain. The antenna being used for the brassboard demonstration program is a one foot diameter parabolic reflector. The beamwidth is approximately three degrees. The resolution of a real aperture radar of this type limits performance with respect to fire control accuracy and target-to-clutter ratio for stationary target detection. A radar capable of performing fire control and stationary target detection will require enhanced angular resolution. Affordable SAR techniques are needed to provide the tank commander with an all-weather STI and fire control sensor.

PHASE I: The first phase will consist of requirements definition, system specification and trade-off studies. The contractor shall conduct a requirements definition study. This study will include an analysis of user requirements and subsequently allocate user requirements to specifications for a SAR upgrade to MGR. Using the SAR specification as a reference, the contractor shall review the design of the MGR and develop and define the hardware and algorithm architecture needed to perform low cost SAR processing. Trade studies shall be conducted to determine the optimal approach with respect to cost and performance. SAR techniques shall be used to increase the resolution of the radar sensor when the radar platform is in motion. ISAR techniques shall be employed to image the target when the target is in motion.

PHASE II: This phase will consist of data collection, algorithm development and a non-real time demonstration of the SAR algorithms. The contractor shall fabricate any data collection hardware needed to interface with the MGR and develop waveforms for the MGR. The contractor shall conduct data collection with the MGR and use the collected data to optimize the SAR algorithms and perform a laboratory demonstration of the low-cost SAR techniques. The contractor shall procure commercial-off-the-shelf signal processing hardware and software development tools for the non-real time demonstration of the SAR techniques. A phase three program will result in a real-time demonstration of low-cost SAR techniques. The low-cost, lightweight techniques developed throughout all phases of this SBIR can be readily extended to other platforms such as UAVs', aircraft and spacecraft.

POTENTIAL COMMERCIAL MARKET: Low-cost techniques for implementation of SAR and ISAR can be used in commercial radars to support applications such as weather observation, topographic mapping and survey. SAR radars are commonly used for surveying, construction of highways and mineral exploration.

A95-042 TITLE: Blind Channel Estimation via Per-Survivor Processing Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop, and demonstrate blind channel estimation and acquisition methods for digital communications signals that are based on so-called Per-Survivor Processing techniques.

DESCRIPTION: Traditional design methods for digital systems operating over a noisy and dispersive communications channel usually employ an adaptive equalizer for channel estimation and acquisition. The receiver uses data-aided techniques to form an estimate of the inverse response of the channel, such that, the cascade of the total channel with the equalizer is a flat, all-pass transfer function. Blind acquisition refers to accomplishing the estimation and acquisition process without the benefit of a training sequence. Per-Survivor Processing (PSP) affords a general framework for approximating an optimum Maximum Likelihood Sequence Estimation receiver in an uncertain environment, such as an unknown intersymbol interference (ISI) channel. PSP provides a method of estimating unknown parameters within the structure of a Viterbi algorithm. The data sequence associated to each survivor in the Viterbi processor is used as data-aiding sequence for the "per-survivor" estimation

of the unknown parameter. This research will attempt to use these PSP techniques in the development of blind forward channel estimation methods.

PHASE I: Investigate theoretical approaches, for blind PSP channel estimation/ acquisition, develop and simulate promising methods and techniques, evaluate and compare the performance of PSP-based techniques versus established blind acquisition methods, and document the approach, design, and performance results in a Phase I report.

PHASE II: Implement and demonstrate computationally efficient techniques on appropriate commercially available processing hardware (6u VME DSP or vector/ array processors) to illustrate the operational feasibility and functionality of the algorithms in a realistic signal environment. The result of Phase II will be a demonstration prototype that employs PSP-based techniques for blind channel estimation and acquisition of digital communications signals such as M-ary PSK and Quadrature Amplitude Modulation.

POTENTIAL COMMERCIAL MARKET: This technology would have tremendous application in the commercial communications market. Communications systems and networks employing digital signaling schemes would all benefit from these techniques. Mobile communications systems, such as digital cellular phones and fax/modems, and the emerging Personal Communication Systems/Networks are just some of the potential commercial markets in the communications industry.

A95-043 TITLE: Innovative Battlefield Visualization Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative techniques and methods to assist in the display of battlefield data and information to the commander. For example, a weather map is the most complete and expedient method to convey current and future weather patterns. This portrayal is readily understandable to any level of expertise. The objective of this effort will be to project battlefield information in this manner, such that rapid and effective decisions can be made by the commander.

DESCRIPTION: The basic requirement for presenting battlefield data and information is a map with accompanying overlays. Much time is wasted waiting for this information to be processed. Time is also wasted if it is presented in a manner that is not readily understood. The two most important presentations are the Intelligence Preparation of the Battlefield (IPB) and the daily Intelligence Summary (INTSUM). This effort is to focus on innovative techniques and methods to both generate and display information of critical importance to the Battlefield commander.

The innovative processing techniques can be focused in one or more of several areas. One of these areas include issues relating to data presentation and how humans perceive information. There are a multitude of methods for displaying different types of information. For example, quantitative data may be expressed as icons that automatically change according to the value represented. Using the weather analogy, temperature can be expressed using a standard thermometer icon, whereby the mercury rises and falls in an animated fashion. In many of these cases, the psychology of the person to which the data is being presented must be taken into account if the data is to be properly absorbed.

The second area to consider involves computational issues related to increasing the speed and resolution of map, terrain, and overlay generation. Currently, the processing of battlefield information is time intensive and laborious. This is sufficient for pre-deployment contingency planning, but not in a fast paced battle envisioned by Air Land Operations. For example, there are gigabytes of terrain data that must be searched and processed with incoming battlefield information. In order to accurately present this battlefield information, enormous processing power would be required in a tactical environment. This issue is a trade-off between resolution and computational efficiency.

Lastly, considerations must be made to issues related to data acquisition, storage and dissemination. An immense amount of data must flow across the battlefield if a common view is to be achieved at all echelons. The importance of this is to perpetuate common goals and objectives amongst battlefield elements. For example, a Battalion Commander should have the same data to support his view of the battlefield, that is a subset of its parent Brigade. Likewise, the Brigade Commander's picture of the battlefield should consist of an exact subset of its parent Division. This will require large amounts of battlefield information be communicated across these elements in a distributed fashion. When combined, the use of these techniques designed to solve the above issues, should lead to sophisticated multimedia presentations. The optimal goal is to give battlefield commanders the capability to perceive battlefield activities from the eyes of their troops.

PHASE I: Explore and develop innovative techniques for presenting battlefield information to the commander. Exploration should consider the media as well as the methodology to be used. Specific topics to be considered are as follows:

a. Not all information will be kept locally with the intelligence producer. This would require that his local database interact with external databases that contain the data that is needed. The local database should be smart enough to know where and how to get and retrieve the information.

b. Once the data is retrieved, it must be processed and displayed in a readily understandable fashion. This may require

the development of an updated Army symbology to include new symbols such as the animated icons, stated above. This may also require the development of overlays such that the 3-dimensional battle can be envisioned.

c. The intelligence producer must then readily illustrate the resultant products to the commander. Rather than providing it in a hard copy fashion, the information may be transmitted to the commander's screen. The briefer could present his information electronically, utilizing teleconferencing techniques.

The final product should be a proof of principle demonstration.

PHASE II: Formalize and extend the concepts developed during Phase I into a Battlefield Visualization Server. The server will be adapted to create readily understandable IPB products and graphic INTSUMs. The software should be robust enough to support tactical Intelligence Analysts in a field exercise.

POTENTIAL COMMERCIAL MARKET: The development of new and innovative data representation, presentation, and storage and retrieval techniques has widespread application. Areas of immediate use include disaster preparedness (similar to a fusion problem), search and rescue, aircraft simulations, and civil engineering and environmental data presentation. As an example, cars of the future will have maps that will overlay roadway situations (e.g., construction, areas of high traffic). There is not enough time for the driver to absorb all of the information on the display and be able to concentrate on the road much less react.

A95-044 TITLE: Display of Sensor Data on Mapping on Army Command and Control System (ACCS) Hardware

CATEGORY: Exploratory Development

OBJECTIVE: The project will involve solving the problem of UTM "corners" which has presented a difficulty in interactive mapping. When the area being mapped is near a UTM corner, it is difficult to use existing database techniques to manipulate the UTM input to assure the information appears on the proper map since at a corner the maps are not square but take on irregular shapes. The solution to this problem will need to be an innovative one and will, when accomplished, provide for cross-applications to other military and commercial systems.

DESCRIPTION: The effort will include display of IREMBASS message information on standard UTM maps using the ACCS Portable Computer. The database of the mapping information will be tailored under this effort to account for the UTM "CORNER EFFECT". when the area being mapped is near a UTM corner, it is difficult to use existing database techniques to manipulate the UTM input to assure the information appears on the proper map since at a corner the maps are not square but take on irregular shapes. The IREMBASS messages are output in modified ASCII format via the RS-232C port on the Monitor-Programmer and in turn allows the user to create sketch maps. The use of the UTM maps will eliminate the need to create topographic information and at the same time locate the UTM coordinates of the sensors so that more accurate targeting/locating data can be generated. The effort is unclassified IAW the IREMBASS Security Classification Guide for this type of effort.

PHASE I: Phase I will involve using the existing Advanced Monitoring System Display software and porting it onto the ACCS Portable Computer including porting of existing Army UTM maps. Phase I will require the software to be programmed in Ada and solve considerations such as memory requirements, timing, message processing and display. UTM mapping of boundary lines (including corners), and interactive display of messages on the mapping data.

PHASE II: Phase II will document the software design and test the product to assure usability. The design from Phase I will be subjected to field usage and inhouse testing to validate the maturity of the design from Phase I. Any deficiencies or operational enhancements for user friendliness will be made during Phase II.

POTENTIAL COMMERCIAL MARKET: Since the ACCS POrtable Computer is a commercial standard and many commercial markets exist for sensor applications (industry and home security), the mapping display of sensor messages will allow any small business to market the mapping function commercially. The government has a need for enhanced interactive display of sensor information for the fielded IREMBASS system on a UTM mapping background and will need to solve the UTM "corner" problem to allow world-wide usage.

A95-045 TITLE: Lightweight Monolithic Opto-mechanical Assemblies for Infrared Seekers

CATEGORY: Exploratory Development

OBJECTIVE: To develop lightweight athermalized monolithic optical/mechanical assemblies for use in the sensor portion of advanced infrared seekers.

DESCRIPTION: Recent advances in the development of lightweight materials which possess high strength, are dimensionally stable over wide temperature ranges, and can be machined to optical tolerances offers the potential to reduce the complexity and cost of future infrared seekers systems and other electro-optical systems for military applications. This research activity seeks the development and perfection of design techniques utilizing these advanced materials in the areas of an integrated/monolithic telescope, its supporting structure, and gimbal functions for line of sight pointing and stabilization. This effort should result in the demonstration of an advanced seekers design which offers significant overall weight reduction; high optical and dimensional stability; passive athermalization over wide temperature ranges; precision line of sight control under stressing dynamic vibrational environments; and low cost rapid fabrication using CAD/CAM manufacturing. Multi band (i.e., visible, infrared) and multi mode (passive, active) operation is also considered desirable. Both advanced materials and design techniques are sought to meet the goals of this task.

PHASE I: An advanced lightweight, athermalized optomechanical seekers assembly shall be conceptually designed and analyzed to demonstrate high precision optical and mechanical performance over stressing environmental conditions. Hardware demonstrations of key component designs is desired to assess technical feasibility.

PHASE II: Design, fabricate, and test an advanced integrated monolithic seekers opto mechanical assembly including the optical telescope, supporting structure, gimbal and pointing/stabilization control subsystems. The prototype seekers hardware shall be capable of being integrated with an existing advanced FPA/ dewar/cryogenic assembly. Qualification type tests shall be performed to assess overall optical and LOS control performance.

POTENTIAL COMMERCIAL MARKET: Technology is applicable to the reduction of complexity, weight, and cost of all commercial electro-optical systems. Examples include producing miniature motors, shutters, and a vast number of electro-topical systems. These are used in all high-tech optical applications.

A95-046 TITLE: Development of Smart Structure with Embedded Optical Fiber

CATEGORY: Exploratory Development

OBJECTIVE: Develop technique to embed optical fiber in a composite material in much a manner that the integrity of the optical fiber will be preserved and the tensile strength of the composite material will not be degrated. Develop composite structure with embedded polarization-maintaining (PM) optical fiber.

DESCRIPTION: A technique or method is needed to successfully embed PM optical fiber in composite material. Curing the embedded composite structure without degrading the embedded optical fiber is a crucial step in the embedding process. Generally, the embedded composite structure should be cured at a high temperature for a sufficient amount of time to preserve or increase tensile strength of the composite structure. The Inertial Systems Branch of the Guidance and Control Directorate is presently conducting an applied research program investigating an interferometric fiber sensor utilizing PM optical fiber to measure bending and twist in an aluminum rod. However, ultimately the fiber optic strain sensor will be embedded in a composite material for a smart structures approach.

PHASE I: First place objective for proposed task is to survey various composite materials that will be suitable for embedding Fujikura PANDA PM optical fiber. This will include evaluating the coefficient of thermal expansion (CTE) for closeness to that of glass and curing specifications for each possible composite candidate. Evaluation of curing methods must be based on maintaining the integrity of the fragile PM fiber and the tensile strength of the cured, embedded composite structure. Strength of the composite structure will be critical since the embedded composite rod will have to withstand bending and twist, and then return to its original state. Examine methods for protecting optical fiber leads exiting composite materials. Provide detailed analysis of all feasible materials and recommend specific composite material. Propose technique of embedding PM fiber into composite material in a rod form.

PHASE II: Second phase objective for proposed task is to develop and demonstrate the technique for embedding optical fiber into a composite material. Perform testing to evaluate tensile or shear strength of embedded composite structure. Analyze integrity or optical performance of embedded optical fiber. Provide detailed procedure description, including a description of all necessary equipment, materials, and facilities, required to produce and demonstrate the embedding technique. Provide test data.

POTENTIAL COMMERCIAL MARKET: The market for strain sensors has grown rapidly in the past few years. There are numerous commercial applications for fiber strain sensors such as earthquake indicators, materials processing (cure) monitors, and structural monitors for bridges, roads and building.

A95-047 TITLE: Landmark Recognition for Robotic Ground Vehicles Using Biologically Based Artificial Intelligence Approaches

CATEGORY: Exploratory Development

OBJECTIVE: This task will explore and develop qualitative and biological artificial intelligence approaches to landmark recognition and place determination utilizing image-based object recognition techniques. Algorithms will be developed to perform recognition of ground based navigational aids such as water, towers, bridges, railroad tracks and distinctive natural terrain features for outdoor robotic applications. Object recognition of indoor objects will include chairs, tables, boxes, walls and door ways. These recognized landmarks will be correlated to vector based digital map data and will demonstrate the ability to perform ground based navigation applicable to unmanned robotic ground vehicles.

DESCRIPTION: This task will develop and evaluate qualitative based methods for landmark recognition and investigate biologically driven artificial intelligence approaches to location determination based on visual cues. Robotic vehicles (indoor and outdoor) in the future will require the ability to recognize locations based on visual surroundings. Vectored map data can provide some insight into the surrounding environment along with global position satellite information. This data alone however will never be complete enough for all robotic navigation exercises, especially in cases where previously planned navigation routes can not be completed. In an indoor application, a bridge out or a bomb cratered road may prohibit the original robotic plan from being completed. In an outdoor application, re-arranging an office or stacking some empty boxes in the hall could destroy a robots' ability to navigate without adaptive capabilities. Object recognition will be required for localized navigation and dynamic route re-planning and adjustment in each of these cases. Military applications for this technology include target reconnaissance using unmanned ground vehicles and automated re-supply vehicles. Commercial applications include automated robotic food delivery for hospitals, robotic mail delivery for office buildings and automated map making.

PHASE I: The first phase will involve developing qualitative artificial intelligence approaches that can be applied to location recognition and landmark determination. The more involved and mature methods that exhibit invariance to rotation, scale and translational effects will then be implemented and tested against a global set of indoor and outdoor landmarks. Results of this phase will be in the probability of correct object classification and an indication of the sensitivity to changes in object perspective.

PHASE II: This phase will involve the development of a software test bed that will serve as an evaluation tool for the approaches developed in Phase I. The software testbed will be adapted to include dynamic route re-planning utilizing available vectored map data and shall incorporate a user interface that allows initial route planning and purposeful obstacle placement that can interfere with the original route that was planned. Data collection of landmark image data and associated vectored map data will address both indoor and outdoor robotic applications. The collected data incorporated into the software testbed will demonstrate landmark recognition and location determination for each of the approaches developed in Phase I. Results of this phase will be a software testbed that demonstrates unmanned robotic vehicles navigation utilizing landmark recognition for guidance.

POTENTIAL COMMERCIAL MARKET: The software testbed developed under this effort represents a product that can be adapted for several specific commercial developments. Commercial applications for indoor vehicle navigation include automated robotic food delivery for hospitals and robotic mail delivery for office buildings. Outdoor robotic commercial applications include inspection of hazardous waste storage facilities and automated map making for environmentally contaminated areas. The testbed product develop by this effort will serve as a design tool to prove out the capabilities in each of these commercial applications.

A95-048 TITLE: Super Efficient X-ray Generator

CATEGORY: Exploratory Development

OBJECTIVE: Develop high-efficiency x-ray sources whose per cent of total output x-ray energy to electron energy is much greater over what is now in practice.

DESCRIPTION: Electronic generation of x-rays is done by bombarding a target material, such as tungsten, with electrons of high energy, resulting in Bremstrahlung and characteristics x-rays. Energy conversion (electron energy to x-ray energy) ranges from less than one per cent to about three per cent, depending on the kinetic energy of the bombarding electrons. The rest of the energy is dissipated as heat and must be disposed of. This solicitation is for development of high efficient, high flux x-ray sources whose per cent of total output x-ray energy to electron energy is much greater over what is now in practice. The source

or sources must not emit x-rays continuously as nuclear sources do, but rather should be switchable (on and off) in a manner similar to electronic sources.

PHASE I: Create and deliver designs for the super efficient high x-ray flux sources. Demonstrate that the designs will meet the requirements, preferably by building a simple prototype tube or a laboratory demonstration. Obtain promise of funding commitment for potential Phase III effort.

PHASE II: Develop, construct, test and deliver one or more working prototype sources.

POTENTIAL COMMERCIAL MARKET: Super efficient x-ray sources have a ready market replacing existing x-ray sources. Super efficient x-ray sources should be smaller, require less cooling, and have higher output flux. These attributes will increase uses for the x-ray device. Commercial markets include all radiographic or x-ray tomographic applications, i.e., non destructive industrial radiography, medical diagnosis, baggage inspection, and integrated chip manufacture.

Cost Reduction: Efficient x-ray sources will be less expensive to operate and more versatile for use. Increased efficiency and high flux density will result in high throughput. This will result in making the x-ray inspection process able to keep up with high volume production. It will decrease the number of inspection systems required for high volume production.

A95-049 TITLE: Real-Time Multi-Spectral Burning Residue in Cannon Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Develop a sensor to detect the presence of burning residue in gun chambers quick enough to warn against loading of munitions during rapid fire.

DESCRIPTION: Occasionally, when using combustible cartridge cases for firing cannons, burning embers or residue remains in the chamber. This condition must be detected and the operator warned not to load the next shell. Spectral measurements have been made to characterize the burning combustible case using Inframetrics 760 and Cohu video images of live-fire residue. The thermo-chemical compositions of burning residue gases with their associated radiances has been computed. Search and tracking of target residue entrained in the bore evacuator flow field prior to start of the loading ram is required.

PHASE I: Using off-the-shelf digital signal processing technology, focal plane arrays, appropriately filtered optics and the spectral measurements of burning combustible case, design and build a real- time, multi-spectral (near to MWIR), sensor capable of collecting and processing radiometrically calibrated spectral data for each pixel in an image at video rates. Demonstrate feasibility.

PHASE II: Extend the concept in time, space and spectral extent. Selection of off-shelf electro-optical devices, the fabrication of hybrid or monolithic focal plane arrays, specialized development of extant algorithms for data fusion, and to minimize/eliminate false alarm, will proceed from Phase I. The final deliverable concept, which would employ automatic search and track of residue targets, and which may operate in the UV to LWIR, will be demonstrated for auto-loaded systems at an Army test range.

POTENTIAL COMMERCIAL MARKET: Development of this technology will extend the spectral range of microelectronics applications in the areas of non destructive testing and inspection of munitions and armaments manufacturing processes, including remote sensing fire-alarms in process and development tests. In particular, a safe-to- load sensor would be useful in the development of munitions. Army operations, such as artillery and tank cannon user training, will experience more accurate, reliable and safer human and autoloader performance. Civil applications are envisioned in agriculture and earth resource mapping, medical diagnostics, sub-surface object and drug detection, automobile exhaust testing, detection of gases and volatiles, control of chemical vapor deposition processes, and powerplant combustion optimization.

A95-050 TITLE: Solid State Angular Rate Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Conceptual design, prototype fabrication and demonstration of a solid state angular rate sensor for precision guided munitions and commercial rate sensing applications.

DESCRIPTION: The current techniques for measuring the rotation rate of various types of conventional and precision munitions include active and passive radiometry, mechanical rate gyros and Yaw Sonde methods. These techniques, while very effective, are relatively complex and expensive to implement in projectiles in production quantities. It would be highly desirable to develop a self contained, small size, low cost, rugged all solid state angular roll rate sensor to measure spin rate for use in munitions

dispensing projectiles and in autonomous and command guided precision munitions. The sensor device should be compatible with micro device fabrication techniques such as thin film deposition and photo-lithography and, in addition, should be capable of large scale batch fabrication techniques similar to that utilized in the integrated circuit industry. The use of bulky electro-mechanical power dissipation components is undesirable for the device design. The desired goals for the device design are:

* Packaging volume of less than 1.5 cc including processing electronics
* Measure rotation rates up to 300 rev/sec with an accuracy of 0.1%
* Bandwidth greater than 100 Hz
* Consume less than 0.1 Watt of power
* Acceleration hardenable to 20,000 Gs
* Capable of operation throughout the military temperature range of -50 to +140 F.

PHASE I: The contractor will perform a detailed scientific and engineering analysis, including, but not limited to computer simulations and analytical analyses to develop a feasible concept of a solid state angular rate sensor compatible with the design goals specified above.

PHASE II: The contractor will fabricate a breadboard prototype configuration of the angular rate sensor specified in the Phase I design and will demonstrate the operation of the device concept.

POTENTIAL COMMERCIAL MARKET: The successful development of this device will provide a low cost, low power, mechanically rugged angular rate sensing capability for aerospace, transportation and manufacturing, such as robotic control, drilling operations, rotating machinery operations and vehicular transportation systems.

A95-051 TITLE: Active Suspension Control Using Preview Information

CATEGORY: Exploratory Development

OBJECTIVE: To enhance active suspension vehicle mobility and ride comfort by incorporating sensor preview information into the control of the suspension system.

DESCRIPTION: Vehicles with active suspension systems have been/are being developed under past/current TARDEC programs. Preview sensor technology programs are also underway. New active suspension control algorithms must be developed to utilize the terrain profile information obtained from the preview system. Vehicle speed and orientation will be essential when considering the preview data. This look ahead capability should improve cross-country ride performance and vehicle mobility.

PHASE I: For phase I of this program the input data requirements for a preview active suspension control strategy should be investigated and identified. A general preview control strategy would be developed and demonstrated with a computer simulation.

PHASE II: For phase II of this program a preview active suspension control algorithm will be developed, installed, and demonstrated for a specific active suspension vehicle system that provides preview sensor information. The details of the active suspension hardware and the preview sensor package will be provided by TARDEC at the end of Phase I.

POTENTIAL COMMERCIAL MARKET: Preview control technology could be a benefit to auto industries, robotics, and autonomous vehicle research.

A95-052 TITLE: Embedded Sensors and Control Mechanisms for Military Tactical Bridging Program

CATEGORY: Exploratory Development

OBJECTIVE: To explore the applicability of the wide variety of microsensors and microactuators, which now exist, for incorporation into our Military Bridging Advanced Technology program. For example, the goal of employing embedded sensors and related control mechanisms on bridge structural components for heath monitoring and other purposes.

DESCRIPTION: Embedded sensors have already gained wide use within the aerospace and automotive industries. Microsensors have evolved from the microtechnology field which is already estimated by industry analysts to be in excess of one billion dollars annually. Some recent studies have predicted that the world market for micromechanical devices will reach eight billion dollars by the year 2000. This effort will 1) assess the current state-of-the-art in this field to compile a database of existing microsensor and microactuator platforms now being developed in the industrial, government and academic communities, 2) evaluate their potential for application to existing and future tactical military bridging assets and 3) select and test applicable sensor/actuator platforms on existing bridging assets, in both laboratory and field environments, to evaluate their role in current and future

military bridge design and production.

PHASE I: The contractor will survey the field to assess the availability of existing microsensor and microactuator platforms and develop a computerized data base to show the current state-of-the-art in this field.

PHASE II: The contractor will assess the above data base and select and recommend those platforms that are applicable to the military bridging field. The government will select from this listing those sensors platforms which will be evaluated under controlled laboratory conditions on selected bridging structural components using existing load frame equipment. The government will down-select those microsensor/microactuator platforms to be included in a follow-on field test and evaluation using existing military bridging assets. The contractor would provide the sensor platforms, monitor the field testing effort and provide a final report containing a summary of the test results and recommendations on the design and incorporation of such microtechnology products into future military bridge design and production.

POTENTIAL COMMERCIAL MARKET: This technology assessment effort and results of the testing should be of great interest to those federal and state agencies who have the responsibility for commercial highway bridging design, maintenance and safety inspection.

A95-053 TITLE: Hardened Subminiature Telemetry and Sensor System

CATEGORY: Advanced Development

OBJECTIVE: Provide flight data characteristics and internal status of onboard functions of present and future smart munitions. The data will be used for munitions design and as input data for future modeling and simulation efforts.

DESCRIPTION: There are nine technology areas of interest: (1) Antenna: requires high relative dielectric constant to reduce size and coating required to withstand burning propellent; (2) Transmitter: S/L Band; (3) PCM Data Acquisition System: channel and frame programmable with signal conditioning, 2M bps; (4) Accelerometer: 3 axis, greater than 100,000 g's; (5) Gyro: roll, pitch and yaw rates, signal processing on ground, software required; (6) Pressure: 100,000 psi to -100 psi; (7) Temperature: propellent temp, windshield temp; (8) Battery: 100,000 g's; (9) Acoustic Scoring Technology: utilized for projectile and telemetry system calibration. The entire system is restricted to the following physical conditions: (1) Volume: 0.46 cubic inches or less; (2) L/S Band Transmit Frequencies: standard telemetry bandwidths; (3) Launch Pressure: up to 100,000 psi; (4) Launch Temperature: up to 3000 degrees Celsius for 10 ms ; Launch Acceleration: up to 100,000 g's.

PHASE I: Develop feasible designs for one or more of the functional areas described above and propose or demonstrate such design(s).

PHASE II: Develop engineering prototypes suitable for incorporation into existing weapon systems or automotive platforms.

POTENTIAL COMMERCIAL MARKET: The developed sensors are adaptable to the broad automotive industry for use in applications to enhance safety and improve navigation.

A95-054 TITLE: Full Flight Video

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a system capable of following, capturing and recording on video a projectile in flight. Continuous motion of the projectile from the muzzle to final impact must be captured on video tape. System will be exposed to harsh weather/environment.

DESCRIPTION: System will include a radar as a primary controller (driver) that will control multiple pedestals located down range. Pedestals will be controlled through fiber optics and track both azimuth and elevation. Each pedestal will have a high speed video camera and lens that will provide the capability to record high speed projectiles, travelling at velocities ranging from 800 meters to 2000 meters per second. The pedestals should be positioned to ensure a smooth tracking and still maintain sharp image of the projectile. When determining location of the pedestals, other parallel ranges must be considered. Smooth projectile speed information and high image quality will be used to calculate pitch, yaw, and velocity of the projectile. All data will be recorded in real time. The pedestals have to be configured and synchronized such that the resulting video will have no drop outs or dead areas of the trajectory. Time must be annotated to a video tape in order to ensure no time overlap or dropouts during the procedure to obtain a continuous full flight video.

PHASE I: Investigate new and innovative ways to capture, process, save and analyze full flight video measurements.

The investigator will obtain all current available information pertinent to this task and determine how to solve the many technical issues associated with the full flight video problem. Phase I should demonstrate that the concept will be able to recover the signal in the event of dropouts. The system must demonstrate that it will work in the existing environment. The investigator shall demonstrate that the system can maintain a live image of the projectile throughout its trajectory and be capable of providing accurate data to calculate pitch, yaw and velocity data.

PHASE II: Implement the new concepts into a working system that is easy to field and align, withstands the shock and vibration of conventional and tank guns, and is portable and reliable.

POTENTIAL COMMERCIAL MARKET: The technology required to develop a fielded system is applicable to various gun/ammunition manufacturers, such as small arms and large caliber guns. The high speed video camera has potential for several applications in the commercial video market.

A95-055 TITLE: <u>3-D Microwave Imaging System</u>

CATEGORY: Advanced Development

OBJECTIVE: To develop a 3-D "microwave camera" for non-intrusive characterization of materials; the primary objective is to detect liquid flow channels in a porous low-loss dielectric medium.

DESCRIPTION: X-ray, ultrasonic and nuclear magnetic resonance imaging techniques have evolved to a high degree of sophistication and these techniques are widely used for biomedical applications. However, microwave imaging techniques are less developed. The development of sophisticated microwave components and improved signal processing techniques suggest that microwave imaging can also be used for a variety of applications. Some potential applications include biomedical imaging, imaging radar, detection and identification of buried objects, and nondestructive evaluation of composite materials. We are interested in a microwave imaging system to study the physics of fluid flow in a porous medium. A 3-D image of liquid flow patterns in a volume (approximately 0.5 to 1.0m3) of a porous material is required. Our specific interest is to investigate the movement of water along preferred flow paths during snowmelt. An understanding of water percolation through porous media is required for basic research in soil and snow hydrology and radar remote sensing application over a snow-covered terrain. Due to the large dielectric contrast between water and ice at the microwave frequencies and the relatively large sample volume required for our applications, a microwave imaging system appears to be an ideal solution. The system should be able to detect water channels whose diameter ranges from 0.5 to 10.0 cm. To reduce the size of the proposed microwave imaging system, a near-field measurement technique is preferred. An array of detectors is preferred over a scanning system to reduce the measurement time.

PHASE I: Demonstrate understanding of microwave measurement techniques and signal processing and inversion algorithms. Demonstrate basic operating principles through model simulations.

PHASE II: Develop, test and modify (if necessary) a practical prototype system.

POTENTIAL COMMERCIAL MARKET: Microwave meteorology, biomedical imaging, noninvasive detection of defects in materials, detection and identification of buried objects.

References:
1. Caorsi, S., G.L. Gragnani and M. Pastorino (1993) Numerical electromagnetic inverse-scattering solutions for two-dimensional infinite dielectric cylinders buried in a lossy half-space, Microwave Theory and Techniques, vol. 41, pp. 352-356.
2. Lin, D.B. and T. H. Chu (1993) Bistatic frequency-swept microwave imaging: principle, methodology and experimental results, Microwave Theory and Techniques, vol. 41, pp. 855-861.
3. Joachimowicz, N., C. Pichot and J. P. Hugonin (1991) Inverse scattering: An iterative numerical method for electromagnetic imaging, IEEE Transactions on Antennas and Propagation, vol. 39, pp. 1742-1752.
4. Bolomey, J.C., C. Puchot and G. Gaboriaud (1991) Planar microwave camera for biomedical applications: Critical and prospective analysis of reconstruction algorithms, Radio Science, vol. 26, pp. 541-549.

A95-056 TITLE: <u>High Energy Laser Plasma Diagnostic Development</u>

CATEGORY: Advanced Development

OBJECTIVE: To develop a suite of high energy laser diagnostic devices to measure plasma parameters.

DESCRIPTION: Hydrogen fluoride/deterium fluoride (HF/DF) chemical high energy lasers (HELs), both pulsed and continuous wave as well as CO2 HELs, typically create large plasmas when interacting with targets. This occurs under a large variety of atmospheric conditions ranging from partial atmospheres of inert gases through fast-flowing STP conditions to high pressure conditions all of which are physically interesting with large commercial potential. Such plasmas can also be created when the laser beam(s) is brought to focus even in the absence of solid targets. The spectral composition, homogeneity, energy distribution, density, and temperature of such plasmas are of primary interest to laser and targets materials developers as well as material scientists and chemists. The ability to time resolve molecule formation in the plasma would be an extraordinarily valuable tool. Knowing such information would allow materials researchers to monitor plasma conditions during materials synthesis processes. Instruments developed should smoothly integrate data acquisition and processing to provide user interfaces suitable for industrial research and process control.

PHASE I: Early efforts should include a study (or review) of existing plasma diagnostics currently utilized in government, academic, and commercial institutions. An effort to analyze and identify critical needs of High Energy Laser Systems Test Facility (HELSTF) materials research customers will also be required. Finally, design of instrumentation and the fabrication of a novel prototype plasma diagnostic should also be a priority in Phase I.

PHASE II: Second phase efforts will attempt a suite of more sophisticated instruments capable of thoroughly analyzing laser plasmas.

POTENTIAL COMMERCIAL MARKET: The commercial market for such diagnostics will prove to be very lucrative. These plasma states are useful in both military and commercial research, including novel material synthesis such as occur during Fullerene formation. Plasma can be used to produce coatings for glasses, contact lenses and other lenses, and medical implants. Additionally, fusion energy laser/plasma interactions are important to the market potential for related instruments.

A95-057 TITLE: Wideband Waveform Generation Using Single Sideband Conversion of a Direct Digital Synthesized Signal

CATEGORY: Advanced Development

OBJECTIVE: Study the limitations on the generation of very wideband chirp signals via single side band (SSB) upconversion of an arbitrary waveform synthesizer output.

DESCRIPTION: Communications and radar applications are increasingly interested in wide bandwidth operation. The millimeter wave (MMW) radar at the Kwajalein Missile Range (KMR) is similarly upgrading to a 2 GHz bandwidth. The goal is to achieve a 50 microsecond, 2 GHz linear frequency modulated chirp with a 0.5 degree RMS phase error and a 4 degree RMS phase jitter pulse-to-pulse. Several techniques are currently under development, but an investigation into using SSB mixers is desired.

PHASE I: Analyze and select a chirp generator design based upon SSB upconversion of an arbitrary waveform generator.

PHASE II: Implement and test a prototype based upon the phase I study. Phase II funding will be dependent upon proving superiority of the SSB approach over techniques currently under development.

POTENTIAL COMMERCIAL MARKET: This project has applications in both the radar and wideband telecommunications industries. The wideband telecommunications industries would include computer networks, hi-volume data communications, and satellite communications. There is a large potential market for any signal processing technique which would make more efficient communications.

A95-058 TITLE: Millimeter Precision Using GPS Receivers

CATEGORY: Exploratory Development

OBJECTIVE: Investigate GPS technology and receiver/antenna configurations to achieve millimeter precision measurements.

DESCRIPTION: Precise positional information to the millimeter level is highly desirable in surveying and other fields, and it is now available using commercial GPS receivers. This project investigates various GPS receiver configurations at the Kwajalein Missile Range (KMR) to provide precise real-time surveys of fixed sensor locations. Additionally, innovative configurations of GPS antennas to measure antenna sag and deformation to the millimeter level in real-time are also encouraged.

PHASE I: Investigate GPS technology and KMR to detail a receiver configuration allowing millimeter precision in surveying fixed sensor locations. Propose a scheme to similarly allow millimeter precision in measuring antenna sag and

deformation. Provide GDOP information.

PHASE II: Implement and integrate the real-time system.

POTENTIAL COMMERCIAL MARKET: Precise location determination is essential to many commercial and government applications including surveying. Phase II proposals should also include an assessment of the commercial applications and markets. The techniques developed could be used to monitor deformation of large structures, such as bridges. Attitude determination applications may be feasible.

A95-059 TITLE: High Resolution Untethered Lightweight Head Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: Development of a low-cost, untethered, color head mounted display having at least 1600 x 1280 pixel resolution, a 140 degree field of view (both horizontally and vertically), and capability for high update rate (at least 60Hz) at maximum resolution.

DESCRIPTION: Head mounted displays are typically used for individual systems for virtual reality, telepresence and situational awareness. The weight, field of view required for effective performance, and the optical system are critical. Metrics for assessing the quality of the physical display should include such factors as luminance, contrast ratio, etc. Standard interfaces should be used to accept signals from any standard I/O source.

PHASE I: High performance display devices are being developed which have the potential to provide solutions to many requirements for an HMD. Identify in detail the technology required to meet all requirements of the stated objective, i.e. high resolution, low-weight, wide field of view, high update rate, and low cost, and the availability of the technology.

PHASE II: If the technology is available, in order to demonstrate proof of principal, a working prototype of the HMD should be built.

POTENTIAL COMMERCIAL MARKET: Entertainment Industry, Education

A95-060 TITLE: Simulation Model Validation

CATEGORY: Basic Research

OBJECTIVE: Statistically sound approaches to making inference regarding model validation, rather than reliance upon subjective appeal, need to be pursued.

DESCRIPTION: "Substantiation that a computerized model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the node!" (Schlesinger, et al. (1979))* is a workable definition of simulation model validation. A distinction must be drawn between model validation and model verification, which refers largely to freedom from structural and programming errors. It is generally agreed upon that in order to validate a computer simulation model, empirical observations are necessary and statistical tests are desirable. Beyond this statement of accord, little substantive work has been accomplished. Omnibus methods for simulation validation do not exist and most approaches are problem dependent. Statistically sound approaches to making inference regarding model validation, rather than reliance upon subjective appeal, need to be pursued. * Schlesinger, S., et al., "Terminology for Model Credibility," Simulaiton, 32 (3), 103-104 (1979).

PHASE I: Nonparametric multivariate statistical procedures appear to have a contribution to make. Validation of certain classes of simulation models may not lend itself to quantification by a metric. It may be more appropriate that a simulation model be determined to be "highly representative" or an "adequate representation" or perhaps un "unreliable representation" of the phenomenon it purports to emulate. Fuzzy set theory may have utility as a modeling tool int his context. These, and other relevant technologies, need to be pursued for applicability to simulation validation.

PHASE II: Pending successful completion of Phase I, consideration of simulation validation in the situation where empirical data are not available should be undertaken. This is an unexplored topic, and no guidance on how to proceed exists. New genres of simulation models -- models whose output is highly graphical, and are more animation than quantitative representations -- are being developed. It is unclear what model validation means in this situation but the need to validate remains invariant.

POTENTIAL COMMERCIAL MARKET: Procedures for simulation model validation that are not problem specific are inherently valuable to developers of commercial simulation software since it would provide a means by which the authenticity of their product might be established.

A95-061 TITLE: Natural Language Software

CATEGORY: Basic Research

OBJECTIVE: To develop embeddable natural language processing software.

DESCRIPTION: Required is software written in ANSI C code runnable on UNIX platforms including the Sun SPARC or SGI workstations that will include and conform to the following descriptions and constraints.
1. A wide natural language coverage grammar and lexicon preferably a Head-Drive Phrase Structure Grammar as described in Carl Pollard & Ivan A. Sag, Head-Driven Phrase Structure Grammar, CSLI, 1994.
2. This system should include a high level language to be used by linguists for enhancing or modifying the supplied grammar and lexicon. This tool should conform to and take advantage of recent work in unification grammar.
3. The runnable system should take word strings as input and deliver at least the following outputs as required by users: fully or partially annotated parse trees, logical forms, discourse representation structures as describe in Hans Kamp & Uwe Reyle, From Discourse to Logic, Lkuwer, 1993. These structures must also be displayable in some user friendly manner, e.g., drawn two dimensional parse trees.
4. All source code must be available to Government researchers, developers, and programmers. Standards of good modular programming should be used so that any part of the system can be easily modified by knowledgeable people.
5. Users should be able to choose among a variety of state of the art parsers, as well as modify or add other parsers.
6. The following intended uses of this software should be emphasized:
a. creation of natural language interfaces to automated systems including but not limited to map based decision aids, virtual reality systems, and machine translation systems.
b. a tool for researches in natural language understanding, machine translation, and natural language generation.
7. The natural language processor should be modularized permitting subroutine calls that pass word strings, syntactic structures, logical forms, discourse structures, and full lexical entries, among others. In addition, it is anticipated that code will be modified by users to permit other data structures to be passed to and from the embedding environment.

Natural language software that is fully embeddable, that we can easily modify for both researcher demonstrations and HCI applications would be very useful to Government and commercial developers of a wide variety of natural language applications. For this purpose this software should look and feel very much like and perform very much like the widely accepted (though developing) HPSG and unification grammars. We also welcome proposed enhancements to the above specifications, including, for example, a similarly embeddable theorem prover.

PHASE I: Conduct a thorough study of the current state of the art in the above items of interest, determine what technologies and software are available for use as is or as modified. Specify and recommend the final product to be developed in phase II. Develop prototype software system for demonstration and government evaluation. Throughout phase I there will be consultation with designated Government people.

PHASE II: Complete software development, preferably in stages. Demonstration of performance on Government platforms by contractor people working with government people, documentation appropriate to above mentioned applications.

POTENTIAL COMMERCIAL MARKET: Superior. Dual-use technology applications include machine translation, hands free/eyes free human computer interaction, telephonic input/output, as well as a development tool for OEMs.

A95-062 TITLE: Network Simulation of Technical Architecture

CATEGORY: Exploratory Development

OBJECTIVE: Develop a network modeling capability to simulate a battle command technical architecture to guide the definition, design, and development of the Army battle command systems.

DESCRIPTION: Fundamental to the Army's goal of establishing Force XXI is an imperative need for the Army to maintain interoperability across multiple telecommunications and information systems. The aggregate of these systems is the Army Battle Command System (ABCS). In order to set up a network that allows interoperable communications among users on the same or different command levels, a viable architecture is necessary. This architecture must be used to design, develop, and test systems in the context of the architecture. Simulation of the architecture and systems operating in the context of the architecture is a cost effective way of evaluating performance characteristics of the architecture. The Army needs a tool that can assist in designing a technical architecture to guide the definition, design, and development of the Army battle command information

transport. To achieve the goal, interoperability and flexibility are required to build a battle information infrastructure across all battle command systems, The information transport will support seamless communications for all users on battlefield, within and among the tactical, strategic, and sustaining base environment, and commercial sector. The tool will help integrate various technologies including tactical multiple gateways, commercial standards and technologies (e.g. ATM/SONET, ISDN), high capacity local area networks, personal communications systems, small satellite platforms and ground terminals, direct broadcast satellite technology, interactive multimedia, video teleconferencing, wideband, and mobile. The tool will be used with defined sets of performance requirements and constraints to simulate an infrastructure that is flexible (facilitate force structure planning and dynamic reconfiguration), interoperable, and cost effective by taking advantages of commercial information technologies through adherence and use of open standards, protocols and products, and state-of-the-art telecommunications. There is a strong desire for the tool to have a pathway into hardware description languages, such as the VHSTC for development of hardware meeting the architecture requirements. This tool should have the capability of assisting in the hardware/software co-design problem.

PHASE I: A design of the tool will be performed. Feasibility will be studied and proved by creating a small prototype.

PHASE II: The tool will be constructed, evaluated, and demonstrated. The tool will be readied for market and tested by potential users. Architecture simulations will be demonstrated.

POTENTIAL COMMERCIAL MARKET: Architecture design is a problem common to both the military and commercial telecommunications systems. This tool will be useful to any commercial endeavor which installs multi-site networks for communications, information processing, and other applications. Large companies with nationwide or international networks will benefit by being able to circulate complex networks before committing the networks to hardware and software solutions.

A95-063 TITLE: Automated Reusable Software Component Search and Retrieval

CATEGORY: Basic Research

OBJECTIVE: To develop an automated method for searching a reuse repository and retrieving reusable components using algebraic specifications.

DESCRIPTION: Research is solicited on the problem of specification-based software component search. This research should make use of specifications written in the OBJ3 language for both queries and keys. It should base its results in a rigorous way on the mathematical theory of algebraic specifications. It should also address practical algorithms for retrieval of reusable components from software base.

PHASE I: Efforts should focus on development of a formal model for automating the search for and retrieval of candidate reusable software components from a reuse repository. The model should formalize automated search and retrieval methods that use algebraic specifications for identifying candidate reusable components in a real-time software component repository.

PHASE II: Efforts should focus on development of algorithms for intelligent retrieval of reusable software components from a reuse repository using the methods developed in Phase I. This phase should produce a prototype search and retrieval tool based on the methods and algorithms developed in Phase I and Phase II.

POTENTIAL COMMERCIAL MARKET: This technology is applicable to all software evolution activities.

A95-064 TITLE: Artificial Intelligence and Visual Techniques for Course Of Action (COA) Development and Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate application of AI and advanced visual technologies for COA development and analysis to enhance Commander's decision support capabilities.

DESCRIPTION: Tactical decision making process involves commander and staff estimate of the situation to develop and analyze COAs to select the best COA for the mission. The process starts with the review of the OPPLAN and the mission analysis, leading to COA development and analysis of the possible alternates. The objective here is to assist the commander to develop and visualize, arrayed forces, action reaction sequence with respect to possible enemy movements (Enemy COA), and develop synchronization matrix for the Commander selected COA. Generic architecture will be developed to support BN, BDE, DIV

Commanders.

PHASE I: The goal of Phase I is to select appropriate knowledge representation scheme and architecture to represent COA objects including terrain objects of the OPPLAN to support visualization of "action /reaction" dynamics.

PHASE II: 1. Limited visual demonstration of Commander's interactions to control battle outcome of alternate COAs, 2. Support for COA analysis and generation of synchronization matrix. It would be required to model attrition, Personnel /logistic projections to visualize unit combat effectiveness as the battle unfolds. The display will include Commanders interaction points to visualize action reaction animation. The demonstration prototype will serve as the foundation for the creation of a fully functional COA analyzer for the commander and the staff in Phase 3.

POTENTIAL COMMERCIAL MARKET: The commercial application of the developed planning/monitoring (Synchronization matrix)/replanning capabilities are directly transferable to commercial manufacturing applications for planning and scheduling in industrial plant complex. It will provide a powerful decision-making tool for industry and manufacturing.

A95-065 TITLE: Modeling Correlation Technology

CATEGORY: Exploratory Development

OBJECTIVE: Provide methods and appropriate automated support that will facilitate the correlation of the different modeling approaches used in the development of requirements for software intensive systems.

DESCRIPTION: Requirements for software intensive systems come from a variety of sources (stakeholders), each representing a view of the system. These views overlap, with no single view representing the entire system. The requirements for the systems are a synthesis of these views, which necessitates an understanding of the interrelationship between the various views. As the complexity of systems increases, so does the stakeholder's reliance on models to assist in the creation, evolution and understanding of their view of the system' s requirements. A variety of modeling approaches have been developed, each providing a particular perspective of what is being modeled. Thus we have approaches for data modeling, process modeling, behavioral modeling, and object-oriented modeling, amongst others, most having some form of automated support. While most of these modeling approaches have been applied in variety of circumstances, some even to other perspectives (i.e. data modeling applied to process modeling), no single approach applies equally well to all situations. Stakeholders select the approach that best suits their needs and use it to create their set of requirements for the system. In order to synthesize the various sets of stakeholder requirements to form a coherent set of requirements for the systems, the stakeholders views must be correlated, conflicts between the views need to be resolved and any missing information must be addressed. This can be accomplished by correlating the models used by the various stakeholders, since that would ensure that the models were views of the entity. This would be true whether the entity was a system, family of systems, or a domain. This correlation would also facilitate the identification of the impact that a requirement change in view had on the other views of the system. The result would be an efficient and cost effective requirements definition process that produces an accurate set of system requirements, with the capability for quickly accommodating change.

Modeling approaches used today have been developed to support a single system perspective (i.e. data modeling, behavioral, process, object-oriented, etc.) as their primary focus. Some correlation has been attempted, either by modifying the primary focus for application to another perspective (i.e. data modeling approach modified for application to process modeling) or as a secondary output from the tool supporting the approach (i.e. tool supports behavioral modeling but can also produce a data model). Unfortunately, the secondary perspective is rarely supported to the same degree as the primary.

This SBIR will addresses the issues associated with providing methods, and associated automated support, to correlate several models of a system, each created using a different modeling approaches. The method should be one that can be used with existing modeling tools, rather than one that duplicates the modeling capabilities found in those tools. The proposed approach should include, but not be limited to, the identification of an initial set of modeling perspectives for correlation, possible interface(s) required with existing modeling tools, use of the proposed tool for identifying conflicts/ inconsistencies between models, use of the tool to identify impact of changes in one model on other correlated models, possible limitations on use of the tool, and use of tool for various modeling situations such as system models, product line models (family of systems), or a domain models (which includes families of systems).

PHASE I: Define method, and automated support needed, and demonstrate feasibility of approach. Define scenarios that describe use of method in various situations. Additional consideration will be given for proposals that identify possible commercialization path, to include potential military and commercial users of the proposed product.

PHASE II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I. Demonstrate prototype using scenarios based on realistic cases.

POTENTIAL COMMERCIAL MARKET: Commercial companies, like their military counterparts, are developing

complex software intensive systems and product lines. Requirements for these systems involve many stakeholder viewpoints, along with associated models, that must be correlated to ensure efficient and cost effective product development. These organizations rely on commercially available tools to support their modeling efforts. A tool that can be used with existing modeling tools to assure that models used on a development are correlated and therefore are views of the same entity would greatly enhance the reliability, supportability, and cost effectiveness of the companies products.

A95-066 TITLE: Software Metrics Global Database

CATEGORY: Exploratory Development

OBJECTIVE: Current/past global software metrics databases or repositories are unwieldy, unmanageable, and at a national level and therefore are hard to validate and difficult to use. What is needed is an innovative scheme, design and implementation of a useful global database, where "global" refers to the organization level, not the entire industry.

DESCRIPTION: The proposal shall be based on a two-tiered approach. The first provides for a scheme, design and prototype of a software metrics database to be established and maintained at an organizational level. Organizations of interest include: Program Executive Offices (PEOs) and Program Managers (PMs) responsible for systems acquisitions; Software Engineering Centers responsible for system support; and private vendors developing commercial and/or government systems. Global information/lessons learned, gathered from projects under its responsibility, would be used by an organization to evaluate how well it was doing its various jobs, how efficient its processes were, and if it was improving over time, and then used as basis for corrective actions and improvement programs. The proposal must: provide a scheme for accomplishing each of these functions; address security issues involved with collection, dissemination and use of sensitive system or contractor data and information; provide a validation strategy; and address the acquisition life cycle from requirements definition through government deployment/commercial distribution and support. The scheme shall NOT assume projects are collecting standard metrics but each has implemented its own preferred state-of-the-practice metrics set/methodology. Therefore, a conversion scheme is needed that allows integration/assimilation of the various formats. As a minimum, the proposal shall demonstrate expertise with CECOM's streamlined Integrated Software Metrics Approach (SISMA) and OPTEC' s Software Test and Evaluation Panel (STEP) metrics. In the second tier, the organization would obtain databases of other organizations and extract information/lessons learned for import into, or modification of, its own database for use as appropriate. The proposal shall provide for development of guidance to assist an organization in accomplishing these functions, and shall include a strategy for time stamping and updating the various database copies. Users would use database information/lessons learned for various life cycle activities as input to those activities for the current or next project. For instance, support data could be used to improve supportability requirements for the next statement of work, or to assure development plans were re-directed to improve supportability of the current project.

PHASE I: Demonstrate proof-of-concept and feasibility. Develop a plan of approach. Address risk and technical alternatives.

PHASE II: Develop prototype and provide a demonstration of capabilities. Develop technology transfer mechanisms such as informal seminars and hands-on tutoring.

POTENTIAL COMMERCIAL MARKET: This technology is of prime interest to organizations developing large, complex software systems, both defense and commercial. Consideration will be given those proposals identifying candidate beta sites, pilot projects, and users, from both government and industry.

A95-067 TITLE: Speech Recognition System

CATEGORY: Advanced Development

OBJECTIVE: Develop a speech recognition input capability for any Army or commercial Virtual Reality (VR) simulation.

DESCRIPTION: One important aspect of VR is the man-computer interface. The information presented to the user of a VR system is tactile through the use of a glove, aural from speakers, or visual from a screen. The user provides input to the system through the use of the glove or by keyboard or other devices. Input in some very sophisticated system is accomplished by following eye or arm movements. Input methodology could be made quicker, easier, and more realistic if the user was able to verbally communicate with the simulation. Spoken communication is not a simple function. The wide variety, tones, and accents of natural speech, even without the complication of different languages, make for a tremendous challenge for VR input.

This effort seeks to develop a speech recognition capability that can be used to more efficiently communicate with the simulated environment. Specifically, a contingency planning training system will be developed that will make use of speech recognition technology. The initial effort will concentrate on scenarios that operational forces (OPFOR) would encounter, but the contingency planning aspects of the project would be easily adapted to commercial applications such as natural disaster response planning, crowd control planning, air traffic control, etc. Follow-on efforts would include expanding the vocabulary of the system, using the system for translation, and adapting the technology to facilitate computer, weapon, or machine operation.

PHASE I: Develop and demonstrate a prototype contingency planning training system (initially for OPFOR) through the use of speech recognition technology. This technology should be adaptable to a wide range of platforms (open architecture). The software should also be easily installed, opened, and used with minimal training. The requirements for the Speech Recognition System (SRS) will serve to increase the realism and response of current and future tactical simulation and training systems. Specific requirements are: 1. speaker independent; 2. near real time reaction; 3. identify both words and numbers; 4. recognize a moderate vocabulary (less than 500 words) with high perplexity; and, 5. recognize continuous speech with an average command accuracy of at least 95%.

PHASE II: Improve the accuracy and increase the vocabulary of the SRS, translation capability to allow NATO interaction, designing and developing a dedicated translation device, and translation of more languages. The SRS will be adapted to control a man-in-the-loop weapon system and a commercial computer controlled milling machine.

POTENTIAL COMMERCIAL MARKET: This program has tremendous dual use possibilities. Training in a VR environment is a growing military market and is also applicable to any local, state, or federal law enforcement personnel, Air Traffic Controllers, fire fighters, machinists, assembly line workers, and hazardous materials transporters. Diplomatic and business interests would benefit from the translation follow-on efforts. Speech Recognition also can be utilized by future systems to facilitate operational input. This would apply to any commercial or military equipment that requires human interaction. Systems that could be controlled by voice commands could mean fewer operators or increased efficiency in programming operations.

A95-068 TITLE: Virtual Prototyping for Personal Protective Equipment and Work Places

CATEGORY: Exploratory Development

OBJECTIVE: Develop a virtual tool to support the design of individual protection items and to reduce the hazards of work/living spaces

DESCRIPTION: In virtually all work places and military operations humans are exposed to potentially fatal hazards. Many attempts have been made to mitigate theses hazards and their effects on individuals. Most recently efforts have concentrated on building and testing actual items. This has proven to be expensive and the resulting knowledge is not easily extrapolated to settings other than those actually tested. Research is needed to develop a virtual prototyping tool that can be used to design protective equipment which protects against ballistic insult, penetrating injuries, blunt trauma, and crushing injuries. In addition, the developed tools need to support design of the spaces in which individuals will work, live and travel.

PHASE I: During Phase I, the contractor will review all previous applicable efforts and research in the fields of body armor, anthropometry, computer modeling, ergonomics, and accident investigation. Based upon this review the contractor will develop a roadmap for the development of a proposed tool and an object oriented simulation architecture which supports rapid prototyping of the virtual design tool.

PHASE II: During Phase II, the contractor will implement the virtual design tool using the roadmap and the object oriented architecture developed during Phase I. Following the implementation, the contractor will use the tool to design a prototype ballistic/blast overpressure protective ensemble and a vehicle crew compartment which will minimize the blunt trauma to occupants during vehicle collision while maximizing the occupants' ability to accomplish required tasks.

POTENTIAL COMMERCIAL MARKET: The developed tool will provide significant benefits to the medical industry in areas such as the training of trauma surgeons and the design of treatment facilities. Strong potential exist in the automotive industry for the design of passenger compartments. In addition, the design of individual protective equipment and structures has broad application in military, law enforcement, and fire fighting applications.

A95-069 TITLE: Distributed Interactive Simulation (DIS) Applications to the Combined Arms Tactical Training (CCTT)

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions specific to CATT problems areas.

DESCRIPTION: The development of the Close Combat Tactical Trainer (CCTT), the initial system to be delivered under the CATT program is underway and is initially focusing on Armor Close Combat. The CCTT can be envisioned as a system of computer driven combat vehicle and Dismounted Infantry simulators and emulators that control other vehicle models and functions and which work interactively over a computer network. Ultimately, CATT will provide the capability to train the total combined arms force on a simulated fully interactive, real time synthetic battlefield. This capability will be used to train and sustain collective tasks and skills in command and control, communications, and maneuver. As the CCTT work progresses and training requirements matured, several training needs have been identified that require additional R&D. These needs are outlined next.

a. The need exists to develop a low cost voice recognition and voice synthesis interface for the dismounted infantry (DI) modules so that soldiers using the manned module can interface with in a realistic manner. The current CCTT manned modules contain a DI module that allows a squad leader to interact with a semi-automated force (SAF) computer generated squad. The computer interface that the student uses to interact with his computer generated squad consist on a 3D visual display, 2D Planned View Display (PVD), joystick and keyboard. This type of input does not allow the squad leader to interact with his squad using voice commands similar to those that they would use in a combat situation. The purpose of this effort would be to develop a voice interaction system that could supplement/replace the computer interface expected to be deployed (>700) the units should be very low cost (goal: approx one to two thousand dollars per module in production). Additional consideration/goals to be considered include: a connected vocabulary size of approximately 600 words and voice independence (or a training period of less than five minutes); Retraining should not be required for a minimum of three days and perform well when the student is under stress.

b. The need exists to develop a method of implementing a generic set of tactical instructions that represent a class of opponents with similar capabilities. The modeling and simulation community relies heavily upon Semi-Automated Forces (SAF) to model opposing forces (OPFOR). To data the tactics implemented for SAF OPFOR have been to base them on our best understanding of a "real" opponent - usually the expected tactics that would be used by the Soviets in Central Europe. The challenge faced today is that there are many more potential adversaries that can modeled and our understanding of their tactics may range from well understood to almost no understanding. What is needed is a method to develop a realistic SAF that is based, not upon our understanding of how someone will fight, but is based upon the potential tactics that could be deployed by an opponent that has certain types of equipment, fighting in certain types of conditions (desert, mountains, forest, etc; summer, winter, etc; day/night; etc). The resultant tactics should allow for "tuning" such that different degrees of capability can be represented, with the most difficult level being more difficult than would be expected from a skilled experienced opponent with similar equipment.

c. The need exists to develop a low cost large screen visual that can be used in combat vehicle "popped hatch" situations. CCTT manned module's frequently operate tactically in a "popped hatch" mode. Under these circumstances 360 degrees of visibility are required. Current CCTT design utilizes 10 CRT's in lieu of one large screen presentation because of a number of deficiencies in current large screen display systems, such as low luminescence. Any proposed design should allow for a smaller package that the current CCTT design, provide a visual image (brightness, fidelity, etc) as the current design and be compatible with the current CCTT computer image generator (Evans & Sutherland Model 3000). The design must also be rugged enough to meet the mobile CCTT requirements (electronic van mounting).

d. The need exist to develop a set of performance feedback displays for a SIMNET/CCTT type training device that will assist an instructor in debriefing a typical training exercises. The CCTT will contain a data logger and After Action Review (AAR) system which can be used to assist instructors in debriefing students after a training exercise. To date, the AAR displays have collected the network DIS data and provided statistical type displays. It is not often easy to determine from these types of displays what actually occurred. For example, it may be possible to determine that a student fired X number of times and got Y hits, but this does not tell why the student actually got the hits or misses.

In summary, any of the "needs" described above could be, in general, the subject of a separate research proposal with the following Phase I & II objectives.

PHASE I: Explore alternative concepts and develop and demonstrate feasible approach.

PHASE II: Develop comprehensive implementation of best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: Video arcade and entertainment industry; commercial simulators such as

flight trainers and driver trainers.

A95-070 TITLE: Targets and Threat Simulators for Development and Operational Testing and Training

CATEGORY: Exploratory Development

OBJECTIVE: Develop threat representative models and simulators to support Developmental and Operational system testing and training.

DESCRIPTION: The Army spends millions of dollars each year developing various threat representative targets and threat simulators to support testing and training. Current problems associated with targets and threat simulators include: size, degree of fidelity, cost, uniqueness, requirements generation and conversion to software. Presented below are four proposed R&D efforts that address specific aspects of the above the problems:

a. Determine feasibility of building a helicopter target, using lighter-than-air technology, which is suitable for use in a training environment. One of the major training problems facing many weapon systems is that full scale targets representing the threat, cost too much to use in a training environment. Reduced scale targets present other problems when used in support of training. The 1/5 scale helicopter target is a prime example. When the 1/5 scale autogyro is used as a training target, problems arise concerning its size, the gunner has trouble acquiring the target because it is so small and the missile often misses the target because of the reduced size. The envisioned large scale helicopter target would be no larger than a 2/3 scale autogyro emulator of a HIND helicopter, weigh no more than 30 lbs, be capable of using the power train from the current 1/5 scale target, be capable of carrying an IR source, be pick-up truck portable, capable of being inflated and deflated in the field, be capable of reliably detonating a STINGER contact fuse and have a per unit cost of $10,000 or less in quantities of 50 or more.

b. Develop a platform for replicating emissions of RF, IR, acoustic and millimeter wave (MMW) signatures of heat signatures. Limitations exist in providing testers and trainers with the required signatures of threat systems to the required fidelity. Signature requirements include: jet engine modulation, propeller modulation, glint and scintillation and ECM signals ; such as flares, suppressors, and IR jammers. Various technologies have been developed that might permit replication of these signatures by electronic methods. This effort examines the feasibility of replicating various threat signatures with a single platform.

c. Develop a threat simulation/SAFOR model for test and evaluation (T&E) applications and establish a quantitative process which validates the performance characteristics and approves tactics and doctrine for this model. A new generation of validated, DIS compliant threat simulations/SAFOR are required to explore the feasibility of performing operational tests in the synthetic environment. Although a multitude of threat simulations and scenarios are currently in use for various Army mission requirements, there is no standard quantifiable process to validate the performance parameters and tactics and doctrine of these threat weapon/SAFOR models to determine their suitability for test and evaluation missions. The validation process and procedures must be flexible enough to handle re-configurable threat models. Using the synthetic environment to perform tests on existing/future Army combat and materiel system is intended to improve the test process and reduce overall acquisition costs. Testing with models and simulations is meant to enhance the live portions of the operational T&E process, not eliminate them. These simulations should take advantage of modern object-oriented design techniques and state-of-the-art technologies in order to be modular, portable, reusable, re-configurable and accurate. Threat representations should accurately depict threat weapon characteristics and OPFOR tactics and doctrine. It is imperative that these threat simulations be DIS complaint in order to have full access to the virtual battlefield.

d. Develop a knowledge based system that will accept military system data in parametric form and weapons systems testing requirements, with various objectives and constraints. Then integrate this data into a meaningful whole with prioritized suggestions for instrumentation and best approach solutions for threat simulators and targets system concepts and specifications. A requirement currently exists for systems that utilize "artificial intelligence " concepts that will take data from multiple sources, analyze it and then generate systems requirements. Present systems are test based relational databases that are limited to keyword searches, and do not accept knowledge based and are incapable of learning and reasoning about instrumentation and threat target simulation requirements. The envisioned system will be very user friendly and will take advantage of commercial off-the-shelf hardware and software whenever possible. If successful, this system could be used by any DoD test activity to determine instrumentation, targets and threat simulator requirements.

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement the best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: The video arcade and entertainment industry; commercial simulators such as flight trainers and driver trainers; support local or federal law enforcement agencies; support commercial product testing;

and possible use as movie props.

A95-071 TITLE: Physical Process Modeling & Simulation for Distributive Interactive Simulation (DIS) Environments

CATEGORY: Basic Research

OBJECTIVE: Develop techniques and methods of modeling/simulating dynamic physical processes for real-time applications in synthetic environments.

DESCRIPTION: Existing synthetic environments contain little or at most only a limited capability for modeling/simulating the dynamic effects of physical processes and complex systems. Specifically, existing simulations do not adequately model/simulate structural integrity of buildings, wind effects on smoke and chemical agents, and the spread of fires as a result of weapon effects. This set of "deficiency examples" evolves from an on-going virtual environment application for training dismounted infantry in a DIS environment and is not necessarily comprehensive. Other "examples" are sought and are encouraged and could be the focus of proposed research. For the dismounted infantry training application cited the simulation of the weapon effects on the structural integrity of a building is needed. The model/simulation would include effects of the impact on the building including the associated visual effect (explosion, fireball, smoke). Also, post detonation effects, such as, floor sag or wall tilt, and the effects on personnel from flying or rolling debris during and after detonation are needed. These simulations/models should also communicate their effects to other models in the system, such as, fire initiation and smoke release.

PHASE I: Design algorithms and develop proof of concept demonstration.

PHASE II: Implement developed algorithms and integrate into designated Army virtual environment applications.

POTENTIAL COMMERCIAL MARKET: The proposed development effort would have application in a number of commercial markets including architecture, structural /civil engineering, and entertainment industry and manufacturing.

A95-072 TITLE: Language Based Speech Recognition Module

CATEGORY: Engineering Development

OBJECTIVE: Develop a module for a speaker independent continuous speech recognition system that exploits the current parallel DSP/microcomputer system technology. Recognizer should extract the meaning from spoken natural language statements and respond as needed by the operator. The system should adapt to the environment, and permit true language based recognition whether the spoken instructions and quires are issued over a military communications net or directly to a desktop or factory automation computer. Phase II results should translate to a practical implementation in a small add-on parallel DSP/ microcomputer module that interfaces to any standard computer configuration, and permits real time spoken language communications between operator and system.

DESCRIPTION: Most current speech recognizers identify a pre-programmed sound and respond by executing a pre-programmed function. These systems are sound based, not language based. A true language based speech recognizer, as defined here, identifies all phonetic components of the chosen language for statement recognition, extracts the meaning of the statements, and responds to the operator in the same language or as otherwise requested. This system will allow an operator to communicate with a computer, not simply emulate keystrokes or mouse moves with words and phrases. Unfortunately, the computation required for such a system is oppressive and has been previously beyond the capability of all but expensive supercomputers. The latest desktop micros, however, contain CPUs that can perform several operations in parallel. Some companies are now developing boards that permit many simultaneous computations to be done on standard workstations and PCs. Some of these boards can be paralleled on a single backplane for development of massively parallel yet moderately priced DSP /microcomputer configurations. These parallel PCs and workstations will permit practical real time implementation of software algorithms that were previously impossible due to the amount of computation involved.

PHASE I: Develop methodology approaches, and parallel DPS/microcomputer configuration and requirements for the development and implementation of a true language based speaker independent, continuous speech recognition system.

PHASE II: Implement best approach in a laboratory based parallel DPS/ microcomputer system test bed. Develop test scenarios and demonstrate the recognition system's ability to understand and respond, in real time, to spoken natural language statements from various speakers in a variety of operating environments. Provide fully integrated prototype module with documentation, source code and development environment.

POTENTIAL COMMERCIAL MARKET: Most computers have a variety of speech recognizers available... very few

are used. Most simply emulate keystrokes or mouse clicks and do not permit true language based operator/system communications using speech. The results of this contract will conclude in the development of a product/system that will understand spoken natural language communications in real time, and in the natural communications style used between people. Since this system will be friendly to use, it will permit easy operator control of all computerized systems, from desktop to factory automation. Since speech is a natural, flexible and very high level means of communicating, this system will reduce operator training time, decrease operator response time, increase operator efficiency, and reduce the total number of required workers or crew size.

A95-073 TITLE: Aircraft Vulnerability Model for Missile Test Debris

CATEGORY: Engineering Development

OBJECTIVE: Provide definitive software of use to Major Range and Test Facility Bases and commercial space ports affording protection to civilian, commercial and military aircraft from debris resulting from normal missile test operations. This software will provide an invaluable tool when used in pretest planning and real time test execution through which hazards to aircraft operating in proximity to or in adjacent airspace can be quantified. This allows for control of risk through prudent use of airspace evacuations and advance notice to aircraft operating in the hazardous airspace. Methodology will employ standards acceptable and adaptable to all ranges or commercial space ports.

DESCRIPTION: It is known that current Army test scenarios for high performance, high altitude missile systems as well as to and from orbit commercial and military vehicles will produce debris either nominally or as a result of any number of inflight failures. The debris has the potential to be carried great distances in significant concentrations as a result of high wind fields aloft. Because of this phenomenon, this debris can present a hazard to aircraft operating in the vicinity through direct engine ingestion, impact with critical control systems or violation of passenger environment containment systems. At the present time, only limited work has been performed in characterizing debris from various aspects of testing or reentry breakup. Stochastic meteorological models with aircraft vulnerability data bases are required to provide a means of quantifying under what conditions debris concentration and composition constitutes a clear navigation hazard to aircraft. It is proposed that this standard software provide sufficient versatility to be universally accepted over a wide range of geographic and test diverse ranges and space ports.

PHASE I: Work will entail expansion of existing efforts to define hazardous vehicle debris characteristics and calculated risk to private, commercial and military aircraft type. Phase I will develop new world-wide stochastic meteorology models, using existing standard range atmosphere models with monthly and daily updates, for propagation of debris into aircraft operating zones delineated by altitude. Clearly, data bases will need to be developed to support these models. Successful model agreement with empirical data will be required for continuation into the next phase.

PHASE II: Important to universal adoption will be to incorporate major features of the complex models above into a methodology able to produce sufficient accuracy on a variety of smaller computer platforms. Developed algorithms will be incorporated into software able to be processed on common personal computer platforms such as high end DOS, Macintosh or UNIX workstations. Software will be validated by empirical data in this phase and made available to a widespread set of users with user feedback incorporated into subsequent versions for further verification and ease of use.

POTENTIAL COMMERCIAL MARKET: This technology has direct impacts on the space and aviation industries. Immediate application will be a definitive risk management methodology for indigenous and non-participant incident aircraft. These models will lead to reduced over-conservatism/speculation employed currently by test ranges/space ports thus allowing less restrictive test scenarios and inevitably lower developmental cost of, to and from orbit vehicles. This will also give the U.S. a competitive edge in the space test market. Taken to an extreme, this software could prevent the eventual tragic consequences of an aircraft or space vehicle encounter with a swarm of airborne debris.

A95-074 TITLE: Hybrid Foil/Magnetic Bearing

CATEGORY: Exploratory Development

OBJECTIVE: Combine a foil bearing and a magnetic bearing into a single compact unit.

DESCRIPTION: Foil bearings and magnetic bearings offer substantial advantages over conventional bearings in high temperature gas turbine applications, in that they do not require oil for lubrication. Foil bearings have start up problems, but at higher speeds have a good load capacity. Magnetic bearings, on the other hand, have good start up characteristics, but need a back

up bearing. The combination of the two should have good synergistic effects, with the main benefits expected to be lower weight and cost, as well as longer life and reliability.

PHASE I: Select compatible foil and magnetic bearings and integrate their designs into one unit. Perform a system study showing the advantages of the combined bearing in a high temperature engine application, such as an existing Army engine. Plan a Phase II test to demonstrate the advantages of the combined bearing system.

PHASE II: Procure/construct the hybrid Foil/Magnetic Bearing and perform a rig test to demonstrate its advantages.

POTENTIAL COMMERCIAL MARKET: A Hybrid Foil/Magnetic Bearing will have a wide application potential for main propulsion engines, APUs (Auxiliary Power Units), natural gas compressors, and most rotating machinery.

A95-075 TITLE: Advanced Engine Sensors and Controls

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate sensors and controls for real-time monitoring, control and optimization of Diesel or gas turbine engines.

DESCRIPTION: Laboratory research has demonstrated that it is possible to sense and control unwanted disturbances in engines, thus broadening the operating envelope through the application of real-time, dynamic control strategies. An example is the compressor surge and stall control demonstrated at MIT. It is possible to project additional application of advanced control concepts, especially for combustion control in Diesel or gas turbine engines. A major barrier to the implementation of these concepts is the bulk and complexity of sensors and actuators in any control scheme. However, recent advances in Micro-Electro-Mechanical Systems (MEMS) and hybrid electro-optic sensor technologies indicate that it may be possible to develop compact, robust sensors and actuators for engine application, for example, in fuel and air-flow control, etc. Innovative concepts are sought which will lead to the development and integration of effective real-time control systems.

PHASE I: Determine the most effective control strategies for engine control and optimization. Develop preliminary designs for sensors and actuators. Assess the potential performance resulting from the application of the proposed system.

PHASE II: Develop prototypes of selected designs, incorporate into suitable engine. Determine effectiveness of systems and effect on engine performance parameters.

POTENTIAL COMMERCIAL MARKET: These technologies have potential broad application to both military and civilian engines.

A95-076 TITLE: Technology for Turboshaft Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative gas turbine engine component technologies which will provide future Army turboshaft engines with increased power-to-weight ratios and/or reduced specific fuel consumption.

DESCRIPTION: The Integrated High Performance Turbine Engine Technology (HPTET) initiative is an integrated DoD/NASA/ARPA industry program structured to meet current and emerging propulsion needs by doubling propulsion system capability around the turn of the century. The general path to doubling propulsion system capability includes, but is not limited to; higher maximum temperatures to increase the output per unit airflow; less weight per unit airflow is required to increase the output per unit weight; and increased component efficiencies for decreased specific fuel consumption while maintaining or increasing component durability and life and maintaining or decreasing cost per unit output. To achieve the necessary future propulsion technology advances, technology strides in the compression systems; combustion systems; turbine systems; controls and accessories; and mechanical systems of a gas turbine engine are required. Specific propulsion technology development areas include high pressure ratio, lightweight compressors; combustors that are lightweight with reduced pattern factors and higher inlet and outlet temperatures; turbines with increased temperature capability, reduced cooling air requirements, high work extraction, and are lightweight; advanced materials/materials systems and innovative structural concepts to accommodate the stresses developed at the required higher speeds, operating temperatures, and reduced weight. Materials under consideration include Ti-based MMC's for the compressor; high temperature materials such as CMCs for the combustor, and a combination of materials with higher temperature capability such as single crystals, intermetallics and composite material combinations for the turbine. Also innovative blade/vane attachment concepts, advances in cooling technology, and concepts involving replacing disks by rings are being pursued. Thus, future propulsion systems necessitate further development in aerothermodynamic design

capability for improved component efficiency levels and improved control of heat transfer; higher temperature and lightweight materials; innovative structural concepts; and compatibility of these developments with affordable manufacturing processes.

PHASE I: Define a novel concept or innovative technology which is potentially applicable to future turboshaft engines. Based on the technology to be pursued, devise a methodology which addresses and substantiates the feasibility of the proposed approach. Define the potential benefits achievable through the application of the proposed concept/technology.

PHASE II: Pursue the technology defined in the Phase I effort. Fabrication and component or subcomponent testing should be perform ed to substantiate the technology and its intended end application. The technology should be suitable for transition into a turboshaft engine.

POTENTIAL COMMERCIAL MARKET: Aircraft gas turbine technology is vital to the US industrial base. Because aircraft gas turbine technology is applicable to both military and civil engines, achieving the IHPTET goals can ensure continued US preeminence in the increasingly competitive international turbine engine marketplace well into the 21st century.

A95-077 TITLE: Light Weight Small 3-10Kw, 120Vac, 60Hz, Diesel Generator Sets

CATEGORY: Advanced Development

OBJECTIVE: Develop a light weight small diesel generator set, 3-10Kw, 120 Vac, 50/60Hz, 3-phase, using VSCF (variable speed constant frequency) permanent magnet generator, composite housing and high speed diesel engine.

DESCRIPTION: The Army is currently replacing its extensive inventory of small generator sets. There is potential to reduce the size, weight, noise, and fuel consumption by using these newer technologies. VSCF technology offers the opportunity to de-couple the engine speed from the output frequency and run the engine at speeds proportional to the load. At reduced loads both fuel consumption and noise may be reduced. Higher engine speed can lead to smaller and lighter engines and generators. Composite technology, if done correctly, offers the potential for stronger, lighter housings.

PHASE I: Preliminary design, components identification, and composite housing design and material selection for a light weight, small generator set in the 3 to 10Kw range.

PHASE II: Detailed design, fabrication and testing of the system. Application of appropriate standards validate the design concept.

POTENTIAL COMMERCIAL MARKET: Potential to replace obsolete small commercial generator sets.

A95-078 TITLE: Low Cost Electronic Controls for Small 3-10Kw, 120Vac, 60Hz, Diesel Generator sets

CATEGORY: Advanced Development

OBJECTIVE: Develop a low cost control system based on modern control techniques for small diesel generator sets, 3-10Kw, 120 Vac, 60Hz.

DESCRIPTION: The Army is currently replacing its extensive inventory of small generator sets. The control systems on these sets date from the 1960's and 1970' s and should be replaced by current technology. The control system should be able to control speed and voltage, monitor elementary faults (oil pressure, overheat, etc.), and have some display capability. There are electronic control systems available, but they are designed for larger engines and are expensive when compared to the cost of a small diesel generator set. A low cost control system needs to be developed that will meet the Army's small generator set requirement. The control system should be generic enough to be used on all small sets of the same configuration. Production cost (not to be confused with developmental cost) should be less than $500 in lots of a thousand or more.

PHASE I: Preliminary design, components identification, and software preliminary design and flow charting.

PHASE II: Detailed design, fabrication and testing of the system. Application to appropriate generator set to validate the design concept. This effort addresses S&T thrusts in advanced land combat and the Star 21 focal values for electric drive technology.

POTENTIAL COMMERCIAL MARKET: Potential to replace obsolete controls on small commercial generator sets.

A95-079 TITLE: Low Cost, High Pressure, Electric Metering Pump for Liquid Fueled, Expendable, Tactical Missile Propulsion Systems

CATEGORY: Exploratory Development

OBJECTIVE: Development of a low cost, high pressure electric metering pump for liquid fueled, expendable tactical missile propulsion systems.

DESCRIPTION: Traditionally, tactical missile systems have exclusively utilized solid rocket propulsion. However, the mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility that can not be met with a solid rocket. On-demand thrust control will be required, which will dictate the use of non-traditional liquid (or gel) based propulsion systems such as: monopropellant rocket, hybrid rocket, bi-propellant rocket, and air turbo ramjet (ATR). To obtain high performance (thrust), the reactors of these systems must operate at relatively high pressure levels (1000 to 2000 psig), thus necessitating even higher propellant supply pressures (1500 to 3000 psig). In addition, pressurized fuel is also required by turbojet, turboprop, and liquid fuel ramject propulsion systems for effective injection into the combustor (required pressure levels are generally under 500 psig). A major disadvantage with the utilization of high pressure propellants is the prohibitive weight penalty associated with high pressure tankage required for direct expulsion propellant delivery systems. The requirement exists for tactical missile propellant pressurization and delivery systems that can be utilized with light weight, low pressure (less than 50 psig) or unpressurized tankage. One attractive method for achieving this objective is a high pressure electric metering pump that could act as both a fuel pressurization device delivering high pressure fuel from low pressure tankage, and as an on-demand fuel metering device that could be employed by the missile as the principle fuel control device. Technology is required for development of low cost light weight electric pump that could be utilized in liquid fueled tactical propulsion systems. It is expected that such a pump would exploit recent technological advances in high speed electric motors (permanent magnet or switched reluctance) and in power switching transistors. The pumps to be developed must incorporate the following features: compatibility with common liquid propellants (e.g. hydrazine, JP-10, IRFNA, MMH, N204), functionality with gelled propellants, ability to deliver fuel from low pressure tankage (less than 50 psig but preferably ambient pressure), insensitivity to pressure fluctuation (inlet and outlet), on-demand delivery of a continuum of low rates (10:1 or greater turn down ratio required), on-demand flow rate control from an external computer through a command signal (either analog or digital), ability to supply flow at the pressure required by the engine over the full thrust range, self-contained system with minimal sensors and a simple control system (no control system is desired), low cost design consistent with tactical missile systems, minimized weight, minimized weight, minimized volume, self-contained sensors and feed-back control (if required), 10 year shelf-life, compatibility with tactical missile environment (storage, transportation, and operating), adaptability to a wide range of engine cycles and configurations. The system must take advantage of the expendable, short duration mission of tactical missiles to minimize cost and reduce weight and volume. Use of commercial (not aerospace) grade components are desired. The pump design should employ generic technology, and should be scaleable to accommodate a wide range of maximum flow rates (.1 to 50 lbm/sec).

PHASE I: Under Phase I effort, a heavy-weight, high pressure electric metering pump shall be designed, developed, fabricated, and demonstrated. This system shall be sized for an ambient inlet pressure, a 1700 delivery pressure, and a maximum .5 lbm/sec flow rate. The pump must be designed to pump liquid hydrazine, and to be powered and controlled through bench top breadboard electronics capable of receiving flow rate commands (analog or digital) from a personal computer. The pump should incorporate as many of the desired features as possible. The contractor may demonstrate the system utilizing water as the delivered liquid. The system must be demonstrated over a wide range of flow rates. At the completion of the effort the device must be delivered to the Government with any associated test hardware, control hardware and software (including source code) for independent experimental evaluations utilizing hydrazine. Sufficient expendable/replaceable hardware must be delivered to support the Government test program.

PHASE II: Under the Phase II effort a flight-weight system shall be designed, developed, fabricated, and demonstrated that incorporates all the desired features. The maximum flow rate and final configuration shall be determined from an analysis of Army tactical missile system requirements. The final design shall be experimentally evaluated under this effort, over a wide range of conditions (transportation, storage, operational). Several devices shall be delivered to the Government for independent evaluation.

POTENTIAL COMMERCIAL MARKET: Commercial space launch vehicles and commercial airliners could utilize the high pressure low cost electric pump developed for tactical missile propulsion systems to significantly reduce acquisition and operating costs.

A95-080 TITLE: Particulate Simulation in Solid Propellant Rocket Exhaust Plumes

CATEGORY: Basic Research

OBJECTIVE: To develop innovative models for the basic physical and thermochemical processes describing two-phase, gas-particle, flows which can replace the existing but inadequate models which currently limit the technology.

DESCRIPTION: Simulation and analysis of many of the aero-propulsion interaction problems of missile development such as nozzle erosion, base heating, and exhaust plume signature require high fidelity models for two-phase, gas-particulate, flows. Computational fluid dynamic models are available which analyze the two-phase processes in solid propellant rocket nozzles and exhaust plumes; however, with the advent of newer algorithms (e.g. finite-volume Roe/TVD upwind solvers) and unstructured grid methodology, there is an opportunity to revolutionize the solution methodology for particle convection in complex, three - dimensional transient and steady state flows. The representation of the particulated motion to date has utilized assumptions and empirical relations which have been found to be inadequate based on recent comparisons with varied sets of data. This present inability to deal with the basic physics and thermochemistry with regard to particulate formation (size), particle/particle interactions, particle/boundary interactions, and particulates in turbulent zones (nozzle boundary layer, plume shear layer, and missile base region) precludes obtaining an accurate representation of the two-phase flow using the best available numerics. New, innovative, and improved approaches are needed to overcome these limitations with research directed towards:

1. Numerical formulation - Particle solution algorithms which are compatible with the gas-phase numerics and adaptive grid schemes, efficient treatment of stiff nonequilibrium source terms - review Eulerian vs. Lagrangion approach.
2. Drag/heat transfer laws - Require significant upgrade as found from detailed Monte Carlo simulations which indicate heat transfer correlations in error by large factors; also supercooling issues and phase change in general.
3. Particle/particle interactions - Not accounted for; require agglomeration models, numerics to deal with size change.
4. Particle/turbulence interactions - Varied approaches proposed, require review and utilization of approach consistent with numerics implemented and turbulence model utilized.
5. Coupling strategies - Gas/particle coupling problem dependent; time-asymptotic snapshot approach entails converging particles once every n-th gas-phase time-step (snapshot approach). For time-accurate calculations, require strong-coupling at each time step. May require non-dilute extension to formulation (void fraction for volumetric effects) for local regions with high concentratoins (e.g. behind the Mach disc, near centerline).
6. Particle/boundary interactions - Need improved formulations for wall interactions (Euler and viscous), methods for heated reflected particles that come back into flow, slag layer approach for entrapment into surface boundary layers, etc.
7. Particles from multiple sources - Ability to heat particles of same size from different origins (e.g from four motors) coexisting at a point, may need probabilistic approach.

PHASE I: Technical approaches will be formulated for each of the above problem areas for inclusion into computational models utilized by the exhaust plume community. At least one innovative model will be coded and implemented to assess the extent of improvement.

PHASE II: The additional model improvements formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government rocket exhaust plume flowfield code. The improved plume flowfield code will be run against the unmodified code for a series of test cases which can demonstrate the ability of the advanced physical and thermochemical two-phase, gas-particulate, flow models to overcome current limitations.

POTENTIAL COMMERCIAL MARKET: The past few years has seen an enormous growth in both the development and application of computational fluid dynamics throughout commercial industry. The modeling of two-phase, gas-particle, flows is key to the understanding and control on many industrial activities such as coal-fueled combustion, bulk materials handling, solids processing, and pollution control. Revolutionary and innovative advancements in computational fluid dynamics for two-phase, gas-particle flows would open a vast new area to this technology.

A95-081 TITLE: High Torque Density Electric Traction Motor

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to examine and develop a high torque density (ft- lbs/ft3) electric traction motor suitable for application in tracked combat vehicles.

DESCRIPTION: The essential performance capability sought is 1600 ft-lbs/ft3 including the motor controller 300 kw deliverable over a 9:1 speed range, liquid oil-cooled at 250 degF oil temp. and a minimum efficiency over the 9:1 speed range to max rpm

of 90%. Length/diameter, including any gearing but excluding the controller should fall between X & Y. The motor may be AC or DC, PM or other, but should not exceed 700V DC equivalent.

PHASE I: The contractor shall design the motor and analyze its performance with special consideration to the efficiency, accuracy, and reliability of the mechanism controlling the torque over the speed range. A thermal analysis of the heat generation and dissipation shall be performed.

PHASE II: The contractor shall build first a bench test model of the controller and test it over the equivalent motor performance range. The contractor shall then build and test a complete motor and controller, testing it over the complete power and speed range.

POTENTIAL COMMERCIAL MARKET: Compact electric motors in this size range have a variety of commercial applications: Heavy duty road and off-road machinery, industrial applications where space or weight is at premium 8-10 inches length and 20-23 inches diameter, and marine applications such as ferries.

A95-082 TITLE: Advanced Ground Vehicle Propulsion Technology

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to examine and develop technologies to increase power density with respect to volume and/or weight, increase efficiency, reduce specific heat rejection, and provide reliability improvements for high output military diesel engines.

DESCRIPTION: Anticipated future high output diesel engine operating conditions include cylinder heat loading greater than 4 horsepower (HP) per square inch (piston surface area), 4 cycle brake mean effective pressure exceeding 300 psia, and brake specific heat rejection to coolant of 12 BTU per HP-Min or lower. Technology areas addressing these targets as well as that of reducing engine weight include, but are not limited to: 1) high temperature tribology (i.e., tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); 2) insulative componentry (i.e., components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports and novel monolithic and coating applications for these components will be considered); 3) fuel injection system/ combustion enhancement (i.e., technologies to be considered include ultra-high pressure injection or other combustion technologies enabling diesel combustion toward stoichiometric conditions without fuel economy degradation); 4) high efficiency, broad range, low inertia and high tolerance to high exhaust pressure, and concepts to use a turboalternator as a compounding unit are being considered for electric drive applications); and 5) engine lightweight structural concepts (i.e., requirement exists to provide dramatic weight reduction in diesel engine structure and componentry). Also concept designs presented shall be consistent with Army initiatives to reduce operating and support costs. Two generic cost drivers 1) causes of electrical/mechanical replacement costs and 2) causes of fuel/fuel distribution costs are directly applicable to this topic. It should be noted that the contractor may select component technologies supporting the above overall objective of the advanced diesel engine area. It is not expected that contractor should necessarily develop a technology system addressing all the areas discussed above.

PHASE I: The contractor shall research technologies and prove concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware initial bench type testing.

PHASE II: Concepts shall be demonstrated in Phase II using a single or multicylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100-hours or more may be required.

POTENTIAL COMMERCIAL MARKET: Although commercial and military engines are of different power ratings, the trend for commercial engines is also toward increasing high brake mean effective pressure and higher operating temperature. The engine areas of interest presented are all generically applicable to future commercial diesel engines currently under consideration.

A95-083 TITLE: Fuel Injection/Combustion for Advanced Military Diesel Engines

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to examine and develop advanced diesel fuel injection systems and other combustion enhancement techniques to allow substantial increased engine power density, increased fuel economy, lower smoke signature as well as lower

emissions and wider fuel tolerance.

DESCRIPTION: Future military diesel engines will be required to operate under very high output conditions approaching 1.5 HP per cubic inch displacement. Fuel injection system/combustion enhancement technologies are being sought to meet the above objectives. Technologies with potential to accomplish these objectives such as staged injection, ultra high pressure injection as well as other techniques which would enable diesel combustion to approach stoichiometric conditions without fuel economy degradation are being sought. To focus the response to this topic, it is emphasized that the trend in military diesel engines is toward four valve, open chamber, quiescent, alternative fuel combustion systems in which the distribution/mixing of the fuel with air is predominantly a function of the injection system. Other novel approaches to achieve high engine power density however will also receive consideration. Concept design presented shall be consistent with Army initiatives to reduce operating and support costs with respect to fuel distribution.

PHASE I: The contractor shall research promising engine technologies and prove concepts from a feasibility standpoint. Concept designs shall be presented and substantiated via analytical calculations, drawings or int he case of hardware initial bench type testing.

PHASE II: Concepts shall be demonstrated in Phase II on a single or multicylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100-hours or more may be required.

POTENTIAL COMMERCIAL MARKET: Although commercial and military engines are of different power ratings, the trend for commercial engines is also toward high brake mean effective pressure. Techniques to enhance combustion to meet the stated objectives are applicable to commercial diesel engines as well.

A95-084 TITLE: In-Line Generator for Light Tactical Vehicle Applications

CATEGORY: Advanced Development

OBJECTIVE: To design, fabricate and test generators suitable for incorporating into the driveline of light tactical vehicles. The generators will provide utility power at 120/208 volts, 60 Hz. This approach provides an alternative to towed power sources that simultaneously improves mobility and deployability of systems requiring redundant power sources, allows for rapid set-up and minimum time delay to full power operation, and reduces power supply O&S costs. The product of this effort should be a prototype machine(s) adaptable to both direct assembly line manufacturing integration or retrofit of existing vehicles. The vehicle in-line generator concept would likely be limited to vehicles used in dedicated applications for specific military missions.

DESCRIPTION: The vehicle in-line generator concept has been verified in a medium tactical truck (2.5 - 5 ton). That generator adds 230 kg to the vehicle weight; as the source of redundant electrical power for critical missions, the in-line generator eliminates a 2300 kg MIL-STD 15 kW towed power unit, reducing power source weight by 90% and eliminating all of the towed unit volume. The problem to be addressed here is to maximize the power output of an in-line synchronous generator in a package that will meet the far more severe installation and weight constraints of the HMMWV and other light tactical vehicles. The overriding consideration demands that the in-line generator does not degrade the vehicle operability, mobility, or reliability. The unit should be as short as possible; it must not be more than 33 cm long, and should not weigh more than 100 kg. It must meet the electrical performance requirements of MIL-STD 1332(B), Class 2B, for utility power sources. The design shall include engine/transmission interface considerations to the 6.2 and 6.5 liter diesel engines used in the light tactical vehicles. Innovative design approaches, advanced materials, and highly effective cooling techniques that lead to high specific power (kW/kg) and high power density (kW/m3) in packages constrained by engine speeds and physical dimension limits are to be pursued. One design shall be for 10 kW at 1200 r/min, another for 20 kW at 1800 r/min, or as near to these values as can be obtained within the size/weight constraints, including the generator controls/voltage regulator in the weight allowance. Military applications include many elements of C4I systems, contact maintenance, mobile medical/dental systems, virtually all dedicated vehicle/shelter systems, emergency power needs, etc.

PHASE I: Perform extensive preliminary design the two principal generators, and document the designs with preliminary drawings. Include discussions of the electrical, thermal, and mechanical performance planned, and the cooling techniques proposed.

PHASE II: Complete the detailed design of the selected unit(s), fabricate, test and deliver the resultant product(s) to the Army for integration into a HMMWV or other light tactical vehicle.

POTENTIAL COMMERCIAL MARKET: Successful demonstration of this technology in light tactical vehicles would provide a clear path for commercial application by vehicle manufacturers or aftermarket sources. The engine class being addressed is found in many full-size pick-up trucks and light delivery vehicles being manufactured today, and the concept is

extendable to smaller, lower power units. The vehicle in-line generator concept is particularly useful for remote site or off-road use in construction, communications, maintenance and repair applications. It provides a means to reduce/eliminate pilferage and vandalism to equipment left in the field. Maintenance is automatically taken care of with normal vehicle maintenance, eliminating in-field servicing demands. The technical knowledge gained from performing this SBIR effort is a primary candidate for Technology Transfer from the DOD to the civilian sector for commercialization. The recreational vehicle market is a principle industrial base for this technology.

A95-085 TITLE: Space Power Beaming with Mid-Infrared Lasers

CATEGORY: Exploratory Development

OBJECTIVE: To advance energy conversion concepts for powering satellites while they traverse the earth's shadow using high energy infrared lasers as the power source.

DESCRIPTION: Space power beaming, or the remote powering of satellites using high energy lasers (HELS) as a power source is now being seriously considered by several large corporations and government agencies, including NASA, DOE, and DOD. The idea is potentially attractive because as satellites pass into the earth' s shadow, their onboard batteries are drained prior to their next solar recharge. Thus, the powering of satellites with lasers could extend satellite service life. Related efforts to convert infrared laser energy are being pursued by DOD and NASA researchers for space propulsion. The NASA long range planners are also interested in this and related technologies in order to overcome the 2 week long lunar "night". Currently, space power beaming advocates are considering HELs with wavelengths able to be absorbed by conventional solar panels. This restricts the laser devices being considered away from existing mature IR HEL technologies. We propose research into methods of energy conversion that would apply to IR laser wavelengths (from 1-10 microns).

PHASE I: Early efforts should provide a thorough study of the problems associated with IR laser energy conversion in space. An innovative approach should be proposed and designed.

PHASE II: Second phase efforts should focus on fabrication of hardware and demonstration of results using HELs and vacuum chambers available at the Army's High Energy Laser Systems Test Facility (HELSTF).

POTENTIAL COMMERCIAL MARKET: Innovative research into infrared energy conversion has wide commercial application. Techniques for space power beaming, once established, could potentially feedback through the energy conversion economy.

A95-086 TITLE: Bifunctional and Catalytic Antibodies

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the potential of using bifunctional and catalytic antibodies in Light Addressable Potentiometric Sensor (LAPS), Fiber Optic Waveguide (FOWG) Sensor, and Planar Optic Waveguide (POWG) Sensor assays. Other technologies which use these antibodies and can detect materials of interest to ERDEC will also be considered.

DESCRIPTION: Current assay protocols with the sensors listed above involve standard immunoassay techniques. The use of bifunctional and catalytic antibodies would serve to simplify these assays, thus reducing the number of bioreagents, and, in turn, the bioagent logistical and stability requirements.

PHASE I: An assay of interest to ERDEC shall be developed using bifunctional and/or catalytic antibodies for either (in order of priority) the LAPS, FOWG, or POWG. The assay must be equal or superior to current assay sensitivities. Recommended assays are: Staphylococcal Enterotoxin B, Botulinum Toxoid, and Bacillus Globigii. The offeror may feel free to suggest an assay of his/her own choosing, especially for a viral assay. Protocols for the synthesis/formation, purification, and storage of the antibodies shall be developed.

PHASE II: The results of the Phase I effort shall be continued and optimized. At least two more assays of interest to ERDEC on dissimilar materials (i.e. toxin and bacteria, not two toxins) shall be developed and optimized. Protocols for the synthesis/formation, purification, and storage of the antibodies shall be developed. The properties of the antibodies shall be fully characterized to include crossreactivity to the other assay materials and to the stability in solution for 24 hours at 37 degrees Celsius and in a lyophilized state at 60 degrees Celsius for one week.

POTENTIAL COMMERCIAL MARKET: The results of this work will offer improved assays for clinical, diagnostic and environmental applications.

A95-087 TITLE: Immunopotentiation Vaccine Delivery Systems for Sustained, Controlled Release of Antigens and Induction of Prolonged Immunity Following a Single Dose

CATEGORY: Exploratory Development

OBJECTIVE: Develop adjuvants for immunopotentiation vaccine delivery systems for sustained, controlled release of antigens and induction of prolonged immunity following a single dose.

DESCRIPTION: This concept has been termed either single-step (oral) or single-shot (parenteral) immunization. Delivery systems are modulated to potentiate the immune response either by delivering the antigen (and adjuvant or adjuvants) either over a prolonged period of time or in a predetermined sequence or by incorporating substances with immunoadjuvant properties (e.g., lecithin and certain biodegradable polymers) as carriers within the delivery system. Genomic immunization with the DNA coding for the antigen or peptide fragment thereof, either naked or expressed in a live vector, represents another approach under development. Particular emphasis should be given to delivery systems designed to achieve single-step/shot immunization.

PHASE I: Develop single-step (oral) or single-shot (parenteral) immunopotentiation vaccine delivery system. Demonstrate induction of prolonged immunity following a single dose to an antigen relevant to the medical biological defense research program.

PHASE II: Demonstrate nonpathogenicity and self-limiting nature of the delivery system and efficacy to the extent of producing protective immunity with a single immunization in an acceptable mammalian model.

POTENTIAL COMMERCIAL MARKET: A step vaccine delivery system as described has extensive potential medical application in both the military and private sector.

A95-088 TITLE: Methods for Monitoring and Semi-Quantitative Assessment of Circulating Hormones

CATEGORY: Exploratory Development

OBJECTIVE: To develop immunochemical test strips for detection of hormones and their metabolites in body fluids such as blood, urine or saliva.

DESCRIPTION: Current methods to pinpoint phase of hormonal cycles require daily blood samples and expensive laboratory analytical procedures. Test strips using immunochemical techniques to indicate ranges of key hormones or their metabolites in blood or urine would allow for more efficient monitoring in quasi -real time. One example would be to monitor urinary metabolites of estrogen and progesterone in order to categorize women into one of several phases of the menstrual cycle.

PHASE I: Demonstrate the feasibility of a semi-quantitative test strip for detection of circulating hormones or their key metabolites in whole body fluids with minimal sample preparation.

PHASE II: Production and testing of a consistent product, including immunochemical reagents, using all relevant QA/QC and GMP protocols. A direct comparison with standard direct radioimmunoassay of the same specimens should be made, as well as extensive tests for cross-reactivity and interferents.

POTENTIAL COMMERCIAL MARKET: The results of this work would have applications wherever rapid, inexpensive assessment of hormones or their metabolites was required. Examples include human and animal research involving female subjects, and monitoring of disease states involving hormonal imbalances.

A95-089 TITLE: Immersive Visualization of Complex Situations for Mission Rehearsal

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate a prototype system which will facilitate the management of and training for complex missions and situations by providing an immersive, interactive, multi - dimensional model of the significant concrete and abstract characteristics of the situation.

DESCRIPTION: Virtual Environment (VE) technology applications are usually used to provide realistic representations of a physical reality. This may be the surface of another planet, a planned building, or the structure of a molecule. Many of the same technologies (e.g., computer image generators, computer models, and helmet mounted displays) can be used to produce visual

representations of abstract data that bear little or no relationship to its physical appearance. The central thesis to be explored and exploited in this research is that the management of many complex real world situations can be improved by providing interactive immersive multi - dimensional models of the significant concrete and abstract characteristics of those situations. Examples of such situations are: planning and conducting peacekeeping and combat operations, weather forecasting, disaster management, and fire fighting. The same technology should improve the training for people who manage those situations. For example, a forest fire could be represented on a database of the actual terrain, with color changes to show different temperatures, and fire fighters represented as icons. Realistic modeling of terrain, weather, fire fighting techniques, and other significant factors could be used to explore predicted changes in the situation over time, to include identifying problem situations and fire fighters at risk. User control of viewpoint would permit examination of specific situations in detail, or obtaining a perspective on the overall situation. User control of other aspects of the simulation (freeze, playback, etc.) should permit greater exploration of alternatives and enhance effectiveness. The representation of a military peacekeeping operation should be similar, with estimated degree of threat in geographic area or the time required to provide additional support to a unit being some of the significant variables represented.

PHASE I: Identify requirements for an off-the-shelf generic system which would meet the needs of at least one military and one non- military application. Develop system functional specifications for a prototype system and identify commercial off-the-shelf hardware and software required, to include databases and models.

PHASE II: Develop the prototype. Develop a military application and evaluate its use. Modify the prototype based on the results of the evaluation. Develop and evaluate the use of non - military application.

Phase III: Implement and market the non - military and military applications.

POTENTIAL COMMERCIAL MARKET: Many complex real - life situations have an inherent three - dimensional representation, and would therefore be appropriate for use with this type of technology. Examples include: air traffic control, weather forecasting, ground traffic control, interpretation of complex audio or visual signals (including sonar returns and sonograms), fire fighting (building and forest), emergency or disaster management, planning and conducting peacekeeping operations, and civilian crowd control.

A95-090 TITLE: Measurement of Stress Adaptability

CATEGORY: Exploratory Development

OBJECTIVE: To develop a screening measure that can be used to identify individuals who can perform effectively when confronted with novel situations that they have not been trained to respond to.

DESCRIPTION: The contractor will develop a conceptual model for the measurement of adaptibility, specifications for one or more measures to be developed, and a validation of the adaptibility measures.

PHASE I: In Phase I the contractor will develop the conceptual model for the measurement of adaptability. The model will specify what types of characteristics are hypothesized to contribute to adaptability and how they are hypothesized to interrelate. The specifications will identify the type of measure or measures to be developed (personality, biographical, cognitive, etc.), the dimensions to be measured, the plan for item development, the type of items to be developed (multiple choice vs. open-ended, scenario - based vs. other, etc.), the type of scoring mechanism to be used, and the content dimensions to be addressed; and will present sample items. The plan for initial validation of the measure or measures will identify the type of criteria to be used and the manner in which these criteria will be used.

PHASE II: In Phase II the contractor will develop the adaptability measure or measures, will develop the criterion measures, will administer both the adaptability and criterion measures in conducting a validation of the adaptability measure/s, and will analyze the validation data.

Phase III: The contractor will demonstrate the applicability of these measures to civilian markets where change is frequent.

POTENTIAL COMMERCIAL MARKET: The adaptability measure developed will be sufficiently generic to have both military and civilian applications. The need to be able to adapt to changing situations is equally important in both types of environments. Just as it is important in the military to know who can successfully adjust to changes in assignments and missions, it is important to know who can successfully adjust to changes in the civilian work force. The measure to be developed has potentially high utility as a screening tool, particularly in environments where change is frequent and an ability to adjust to such changes is critical.

A95-091 TITLE: Neutralizing Monoclonal Antibodies for Specific Toxins and Threat Agents

CATEGORY: Basic Research

OBJECTIVE: Provide neutralizing monoclonal antibodies for specific toxins and threat agents.

DESCRIPTION: Using traditional approaches or novel techniques of in vitro stimulation of human spleen or peripheral cells or recombinant conversions of mouse monoclonals, produce humanized neutralizing monoclonal antibodies with specificity for important toxins and threat agents. Antibodies for specific toxins such as: bacterial (botulinum, staphylococcal enterotoxins), protein synthesis inhibiting plant toxins (ricin), protein and peptide toxins of other biological origin (including pre- and postsynaptic neurotoxins, and membrane active substances), and other bacterial toxins such as clostridium prefringens toxin, are of particular interest. Physiologically active compounds of biological origin are also of interest as are anthrax, tularemia, Q-fever and human pathogens of Alphaviridae, Flaviviridae, Bunyaviriade, Filoviridae and Areaviridae.

PHASE I: Generate antibodies and demonstrate neutralizing specificity in a model system.

PHASE II: Produce research quantities of the specific humanized monoclonal antibodies.

POTENTIAL COMMERCIAL MARKET: Several militarily relevant toxins (e.g., Staphylococcal, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regimen exists. Neutralizing monoclonal antibodies against these toxins would be a significant advance in protecting the public health.

A95-092 TITLE: Design of Subunit Vaccines Inducing Cytotoxic T Cell Responses Against Infectious Disease Threats

CATEGORY: Exploratory Development

OBJECTIVE: Design and test subunit vaccines that induce protective cytotoxic T cell responses against infectious agents that infect or parasitize cells bearing MHC Class I molecules. Such vaccines will include specific peptide sequences derived from proteins produced by the pathogen and subsequently processed and expressed in the context of MHC Class I molecules by host cells. Such vaccines will be characterized by the induction of highly specific and functionally active T cell populations with the capacity to target infected cells and eliminate the pathogenic agent.

DESCRIPTION: Recently described techniques permit the elution and identification of specific short polypeptide sequences from MHC Class I molecules infected with pathogenic agents or transfected with genes from such agents. These peptides, in the context of Class I molecules, confer upon the immune system the ability to recognize and subsequently target cytotoxic T cells (CTL) to pathogen-infected cells with exquisite specificity. These techniques have been best defined using model systems for which CTL epitopes have been previously identified, but the approach holds great promise for a number of important infectious diseases such as malaria, denque and others where CTL mediated responses are known to be important to protective immunity. Under this solicitation, peptide sequences representing potential epitopes to be included in a CTL vaccine will be identified and evaluated.

PHASE I: Demonstrate feasibility by preparing one or more cell lines of defined Class I type infected or transfected with a pathogen(s) or specific genes from a selected pathogen(s). Identify critical peptides associated with these Class I molecules to include determination of sequence and the ability of such peptides to sensitize target sells for CTL mediated killing.

PHASE II: Engineer one or more subunit vaccine using synthetic peptide or recombinant expression technology incorporating such epitopes and demonstrate protection in a suitable model system.

POTENTIAL COMMERCIAL MARKET: Vaccines that induce protective CTL responses are likely to be required for such major infectious diseases as HIV, influenza, malaria, dengue and others. The commercial potential of efficacious vaccines against these diseases is enormous.

A95-093 TITLE: Identification of Mosquito Attractants Produced by Humans

CATEGORY: Basic Research

OBJECTIVE: Develop a new category of mosquito repellents by masking/blocking volatile attractants produced by humans.

DESCRIPTION: Diethylmethylbenazmide (deet) is the active ingredient in almost all commercial and military arthropod

repellents. Deet was discovered in a random survey of compounds for repellency. Attempts to improve the efficacy of deet by modifying the chemical structure have not been successful. Problems associated with deet include a lack of broad spectrum efficacy, odor, solvent properties, limited duration and low user acceptability. Concerns about deet's effects on health have resulted in use restrictions in California and New York. A more effective, safe and acceptable repellent is needed for military and civilian use.

PHASE I: Phase I would consist of: 1) a literature search to identify the human/animal volatile mosquito attractants identified to date, and 2) studies to identify individuals highly attractive and unattractive/repellent to host-seeking mosquitoes. Anecdotal reports, and field experience by WRAIR entomologists, clearly identify some individuals as more attractant/repellent to mosquitoes. This observation requires validation. Individuals highly attractive and unattractive/repellent to mosquitoes could be identified, and the response quantified, using modified olfactometers and laboratory reared mosquitoes.

PHASE II: Phase II would involve trapping, quantifying and identifying human/ animal volatile materials responsible for mosquito attractancy/repellency. This study could be conducted using low-temperature vapor traps, a multi-port mosquito olfactometer and highly sensitive analytic methods (e.g., gas chromatography-mass spectroscopy) to identify the chemical structure of the mosquito attractants/repellents produced by humans. Once characterized these materials could be labeled and used in studies to identify the corresponding receptor on the mosquito.

Phase III: Phase III would involve synthesis and evaluation of masking or repellent compounds based on the tertiary structure of the natural attractant/ repellent or mosquito receptor.

POTENTIAL COMMERCIAL MARKET: Development of a new generation of insect repellents based on masking/blocking the mosquito attractant could greatly reduce mosquito transmitted diseases, for many of which there are no licensed vaccines and parasite drug resistance is widespread. There also would be a large commercial market for a more effective repellent against nuisance mosquitoes.

A95-094 TITLE: Development of Lightweight, Portable, Minimally-Invasive Physiologic Sensors for the Multi-site Determination and/or Quantitation

CATEGORY: Exploratory Development

OBJECTIVE: To minimally-invasively measure (at multiple sites) the systemic concentrations of diagnostic proteins associated with traumatic injury. The sensor must be capable of interface with standard computer input ports, in order to record, store and eventually transmit the oxygenation status data.

DESCRIPTION: There is a growing need for sophisticated biochemical and physical sensors to monitor the physiologic status of casualties on the battlefield. Monitoring of this type will augment current abilities to diagnose and triage trauma victims, and to evaluate tissue damage, metabolism and prognosis during evacuation (transport), as well as during stabilization, resuscitation and treatment. Such sensors should collect desired information rapidly and reliably, and interface with both real-time display devices and data storage devices of standard computers. Currently-described sensors must be capable of sampling multiple sites simultaneously.

PHASE I: Produce prototype components for such a system from existing or novel materials, capable of demonstrating the proof-of-principle.

PHASE II: Integration of all components into a pre-production prototype. Demonstrate the features and capability of the prototype in tissues simulating battlefield hemorrhage and shock.

POTENTIAL COMMERCIAL MARKET: The use of such physiologic sensors is anticipated not only under battlefield conditions, but also in a variety of emergency medicine scenarios, including: emergency response teams (both urban and rural), hospital emergency rooms, surgery, intensive care and coronary care suites, etc.

A95-095 TITLE: Medical Decision Algorithm for Pre-Hospital Trauma Care

CATEGORY: Engineering Development

OBJECTIVE: To develop computer algorithm(s), capable of accepting data from physiological sensors already under development, which will operate in small, hand-held personal computers such as the Soldier Individual Computer, 21st Century Land Warrior (adapted for medical applications).

DESCRIPTION: This decision algorithm must be capable of accepting multiple inputs, (such as tissue pH, tissue 02, tissue

blood flow, cardiac output, heart rate, ambient temperature, and body temperature), and provide output in 15 seconds or less. Output would be a combination of "likely survival" and " approximate survival time", which could each be digitally displayed, but must be displayed as RED, AMBER, GREEN (RED=death imminent; physiological and physical parameters 20% of "normal"; AMBER=serious to extraordinary deviation from normal physiology--death likely in 30-60 minutes; physiological and physical parameters 50% of "normal"; GREEN=survival likely; physiological and physical parameters within 80-100% of "normal".)

PHASE I: Develop realistic algorithms based on scientific literature values, previous models and validated assumptions, including descriptions above.

PHASE II: Validate algorithm with experimental data; refine algorithm, compile algorithm and necessary supporting software, drivers, etc. for incorporation on microprocessor chip. Phase II model must be capable of updating data from previous readings, in order to determine whether intervening treatment was effective, or whether spontaneous course of casualty is changing.

POTENTIAL COMMERCIAL MARKET: Exclusive of the U.S. military medical applications, the commercial market is enormous. Potentially, this device could be used on every vehicle responding to emergencies and by every paramedic, as well as for triage by qualified medical personnel.

A95-096 TITLE: Stable Biodegradable Polymers for Delivery of both Polar and Nonpolar Drugs

CATEGORY: Exploratory Development

OBJECTIVE: To develop stable biodegradable polymers or other biodegradable excipients that will effectively and safely sustain-release anesthetic/analgesic drugs at therapeutic yet nontoxic levels over a prolonged period of time. The excipients must allow for the delivery of both polar and nonpolar drugs or compounds.

DESCRIPTION: Pain following traumatic injury is universal, but dramatically increases in frequency during war. Presently used anesthetics, though effective, require repeated administration and are plagued by dose control problems and unwanted side effects. Sustained-release formulations of select local analgesic/ anesthetics need to be developed, which will provide prolonged (days to weeks) pain relief, while reducing debilitating side effects. Preliminary work using novel drug delivery systems has shown that a drug's anesthetic effect can be sustained while its toxic effect can be greatly reduced or eliminated. This advantage will likely result in salvage of effective anesthetics now shelved due to their toxicity. Furthermore, the promise of using drugs that provide selective anesthesia (pain control without loss of motor function) may become a reality when such delivery systems are employed. Such advancements in pain control offer tremendous advantages for use in military evacuation scenarios and would have broad applications in civilian medicine.

PHASE I: Develop new or modified polymers for delivery of both polar and nonpolar drugs (specifically anesthetic drugs) that could be safely injected intravenously, intrathecally and into soft-tissue.

PHASE II: Incorporate polar and nonpolar drugs or compounds (specifically anesthetic drugs) into the polymers so that they sustain-release drugs as they biodegrade. Perform preclinical trials to test efficacy for pain control.

POTENTIAL COMMERCIAL MARKET: Development of sustained-release formulations of conventional and novel anesthetics/analgesics will potentially allow long-lasting anesthesia following single dose therapy. Such a capability will minimize wounded soldier decrements and the burden on medical support resources. Improved methods to control pain, acute and chronic, will also have a major impact on major medical, psycosocial, and economic problems of society at large.

A95-097 TITLE: Computer Model of Red Blood Cell Chemistry

CATEGORY: Engineering Development

OBJECTIVE: To develop an exact working model of red blood cell chemistry to aid in the design of improved blood storage solutions

DESCRIPTION: A preliminary model already exists, and should be used as the point of departure in the current refinement and development of the red cell chemistry model. The original model was developed by the RAND Corp (1950's & 1960's), and was refined by UCLA School of Medicine--called "Fluid Mod". The original model, a mathematical engine, solves a very large number of pre-steady state, steady state and equilibrium equations. The model to be developed must exactly describe hemoglobin chain interactions and their interaction with hydrogen ion, other metabolic inputs such as metabolite concentrations,

pH, etc. in another program and pass them to the original "engine", which then solves all of the equations. The new model must use molar, rather than molal concentrations.

PHASE I: The objective in Phase I would be to re-write the original model from the original (and awkward) Fortran to C++, and interface the model to a windows environment on common microcomputers, with adjustment of the parameters to those needed for the calculations from the usual molar physical units used in either physiology or biochemistry.

PHASE II: The objective of Phase II would be to extend the work completed in Phase I to include a general chemistry program as well as all of the red cell functions, hemoglobin chemistry included.

POTENTIAL COMMERCIAL MARKET: Completion of the Phase I objective, using "Fluid Mod", will have widespread interest in medical schools for teaching electrolyte therapy in the emergency room, etc. The results of Phase II will have a broad appeal to students and researchers doing kinetics and thermodynamics of biological or purely chemical systems. Thus, the potential Contractor must show knowledge of how to bring the programs to market.

A95-098 TITLE: Advanced System for Worldwide Surveillance of Rickettsial Disease Antibodies

CATEGORY: Advanced Development

OBJECTIVE: Develop, laboratory validate, and field test a system for surveillance of rickettsial diseases on a worldwide basis. The successful product will be customized for geographic regions and simple enough to use reliably in central diagnostic facilities of developing nations.

DESCRIPTION: Rickettsial diseases like epidemic typhus and scrub typhus have had major impact on armies in endemic areas for hundreds of years. Although curative antibiotics are available, an infected soldier is likely to be out of action for some days before diagnosis and for days for weeks after treatment. Currently, we have very little information on risk of these diseases within any given geographic region because the current tools for diagnosis are either inaccurate (Well-Felix test) or cumbersome (indirect immunoflourescence assay). Specific examples of our poor knowledge of risk of these diseases include an outbreak of spotted fever attacking two-thirds of U.S. forces deployed to Botswana, the discrepancy between some 800 cases of scrub typus reported annually from Thailand compared to the estimated actual incidence of 20,000 cases per year, and the discovery this year of a new ehrlichial pathogen in Wisconsin. In a recent meeting sponsored by the World Health Organization, the great need for a program of surveillance was acknowledged, but current diagnostic tools were considered too difficult to standardize in many laboratories. A new diagnostic approach should satisfy the following criteria: 1) Simplicity: Accurate use should require minimal training; 2) Speed: One technician should be able to complete 30 serum samples in one day; 3) Accuracy: Specificity and sensitivity compared to indirect immunofluorescence assay should produce results which give at least a relative indication of the amount of antibody reacting with each antigen; 5) Minimum equipment requirement: The assay should not require expensive equipment, such as a fluorescence microscope or a spectrophotometer; 6) Easy shipment: Reagents should be stable enough to allow shipment at temperatures which do not need to be lower than 4°C; 7) Broad applicability; Versions of the test system should be capable of measuring antibody to the major know rickettsial (typhus group, scrub typhus group, and spotted fever group) and ehrlichial (chaffeensis type and sennetsu type), as well as Q fever; and 8) Controls: Each test will include appropriate negative and positive controls to assure that conditions for each test are correct.

PHASE I: The initial effort will require optimization of the components of the assay in the laboratory, using known sera. The various components will be assembled into regional packages (e.g., typhus; spotted fever, scrub typhus, Q fever, and sennetsu in Southeast Asia) with a "user friendly" format that provides complete kits and instructions.

PHASE II: Field validation will consist of distribution of the kits to collaborating countries with the intention of collecting 30 representative sear in each country each month. Experience from this effort will establish whether the assay system requires modification.

POTENTIAL COMMERCIAL MARKET: A successful test system would serve two different international markets. First, the system could be sold to individual governments and world health organizations for the purpose of continuing surveillance. Second, the system could be used for individual patient diagnosis where the diseases are found to be prevalent.

A95-099 TITLE: Model the Interface Between a Respirator and the Human Face

CATEGORY: Basic Research

OBJECTIVE: Develop graphical and mathematical models of the M40 protective mask, the human face, and the interrelationship between protective mask and face when the mask is worn. Develop predictive techniques for estimating the levels of comfort

and protection provided by a mask prior to fabrication of prototypes.

DESCRIPTION: Each time a new program is initiated for a protective mask, large numbers of volunteers are required to verify the fit and comfort. Models do not presently exist of the human face and the protective mask and techniques for analyzing their interaction when the mask is worn do not exist. If these models can be developed, designers would be able to use their computer to analyze the impact of changes to the design quickly and easily. Final designs would still have to be verified with large samples of real persons, but changes could be quickly analyzed. The net result would be a reduction in the time required to develop and test new masks. The techniques developed for creating the models would apply not only to military respirators but to respirators worn by firefighters, scuba divers, and hazardous materials handlers.

PHASE I: Conduct literature reviews to identify existing models of the interrelationship of the face with masks or other items of clothing or equipment worn. Identify relevant portions of models that are of use in this effort. Develop mathematical and graphical models (suitable for AutoCad for example) of mask, face, and interrelationship.

PHASE II: Develop predictive techniques for determining the relative levels of comfort and protection provided by prototype masks prior to fabrication of prototypes.

POTENTIAL COMMERCIAL MARKET: The techniques developed for modelling the face and respirator would be valuable to developers of commercial respirators for scuba divers and for fire fighters. They would be able to test prototype designs of respirators on the computer rather than requiring large samples of people each time a change occurs.

A95-100 TITLE: Remote Measurement of Atmospheric Temperature and Moisture

CATEGORY: Exploratory Development

OBJECTIVE: Remotely measure more accurate profiles of atmospheric temperature and moisture in near real-time. A suggested approach would be development of a tuneable microwave radiometer for sensing temperature and atmospheric moisture using oxygen and water lines in the atmosphere. The resulting system should be compact and lightweight and should be able to rapidly and precisely select a large number of both water and oxygen frequencies under software control and accurately measure the corresponding brightness temperatures.

DESCRIPTION: Accurate first-round fire-for-effect artillery requires timely knowledge of the meteorological parameters of the atmosphere along the trajectory of the round. Systems relying on balloons are inherently slow and impose a large logistical burden. Our best current radiometric sensing technology still relies on a two-point non-tuneable technology for sensing atmospheric water. More frequencies, under precise software control, should permit improved accuracy.

PHASE I: Design a compact, portable, and precisely tuneable water vapor radiometer with at least 100 frequency channels distributed in the 18-23 GHz range and the 30-40 GHz range. All channels should be selectable under software control and should be measured to 0.2 K or better. Channel centers should be selectable within 1 MHz or less.

PHASE II: construct a working prototype of the Phase I design, including a laptop computer control system and software to retrieve atmospheric liquid water and water vapor overburdens, and demonstrate features and performance with simultaneous, co-located radiosonde measurements.

POTENTIAL COMMERCIAL MARKET: Atmospheric temperature and moisture are key parameters for almost every aspect of weather and atmospheric environment. A compact, automated, real-time temperature and moisture sensor should find many applications in general meteorology, aviation support, and agricultural planning and climate studies, replacing the radiosonde for many applications and going places where it would be inconvenient to maintain a crew to launch radiosondes. In addition, the moisture measurements at which such an instrument excels would be valuable for determining phase-lags due to the atmosphere which impact geodesy and radio astronomy.

A95-101 TITLE: Cost Effective Flue Gas Cleaning via Irradiation with Fast Electrons, Electron Beam Dry Scrubbing Process (EBDS)

CATEGORY: Exploratory Development

OBJECTIVE: Develop stable EBDS techniques which can be used to remove Sulfer Dioxide (SO2), Nitrous Oxides (NOx) and other contaminates from flue gas. The thrust of the research will be design and development of devices to produce to provide suitable electron beams in a cost effective manner.

DESCRIPTION: A great deal of concern globally has focused recently on the effects of smoke stack emissions, particularly acid rain from fossil fuel power plants. For example, German legislation requires removal of SO2 and NOx from flue gas emissions at nearly all power plants. The German Institute of Thermal Turbomachinery has studied the optimization of removal efficiency and energy consumption at its facility for emissions scrubbing via the electron beam process. In the US, EBARA Environmental Corporation has produced a pilot plant in Indianapolis based on the EBDS. In both cases the irradiation of the flue gases produces active radicals and atoms which react with SO2 and NOx to form their respective acids. In the presence of ammonia (NH3) these acids are converted to ammonium sulfate and ammonium sulfate-nitrate, i.e. useful fertilizer. It is desired that technology developed at the Department of Defense (DOD) and contractor organizations focusing on electron beam production for military purposes, such as flash X-ray machines, be adapted to resolution of problems inherent in scaling the EBDS technique to smaller applications. Such applications include pollution remediation where source power and size are highly constraining factors. Most engineering work to date has focused on large power plants. This topic focuses on cost-effective, compact e-beam production for cleaning-up fossil fuel emissions from maritime vessels, tractor trailers, locomotives, small power plants, refuse incinerators and a host of other small contributors to atmospheric SO2 and NOx. The Army is interested in production of compact, high power sources and microwave generators that can produce relativistic electron beams for military purposes. As an example, the " Super-Reltron" microwave tube is a very efficient, high power radio frequency source representative of a technology which might be coupled with LINAC technology to produce the high average power, relativistic e-beams necessary for the EBDS process. It would be beneficial if the DoD's heavy manpower investment in e-beam technology could be transferred to the civilian economy. Proposals should not be limited to the LINAC approach. Electron beam energy and current may be chosen around the parameters dictated by efficient operation of the EBDS process.

PHASE I: Develop theoretical model of a cost effective e-beam source for use in EBDS process. Perform a theoretical analysis determining relationship between cost and scaling.

PHASE II: Construct a working prototype of the most suitable method indicated by Phase I.

POTENTIAL COMMERCIAL MARKET: A compact EBDS technology would be of inestimable value in both developing and already industrialized nations. Recent international agreements have committed countries to setting and enforcing clean air standards. The US is a world leader in the evolving environmental technologies business; transfer of DoD know-how into this rapidly growing sector of our economy promises to both strengthen our economic stake in an expanding competitive market, while further bolstering the prestige and image of the Army Research Laboratory as a leader in this area.

A95-102 TITLE: Portable Laser Induced Breakdown Spectroscopy Sensor for Toxic Metal Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Development of a portable sensor, based on LIBS technology, for the detection of toxic metal contamination

DESCRIPTION: A specific need exists for portable sensors that are capable of real-time, high-sensitivity analysis of the toxic metal contaminant Sb, As Be, Cd, Cr, Co, Pb, Mn, Hg, Ni, Se, and TI. Sites of interest on Army installations include structures, firing ranges, soils, and waters. Sensitivity and specificity to this wide range of metals poses a major technological challenge. A particular advantage of a portable system for real-time trace metal analysis would be the saving of considerable time and cost since, at present, samples must be acquired from sites of suspected contamination and then sent to off-site laboratories for subsequent analysis. The spectrochemical technique known as Laser Induced Breakdown Spectroscopy (LIBS) is considered to have potential for toxic detection in a wide variety of environments. The LIBS technique utilizes a pulsed laser to produce a plasma in gases, aerosols, particulates, liquids, and solids. The hot plasma is the source of a characteristic wavelength emission for each constituent metal. A number of examples of successful laboratory demonstration of the LIBS technique for metal detection have been published. What has been impeding the development of this promising technique into a commercial product for field use is the requirement of an affordable and reasonably compact laser source for the necessary high energy, high peak power laser pulse. However, improvements in laser design have led to simplicity of operation, reliability, compactness, ruggedness, and reasonable cost. Coupled with the development of small detectors capable of multispectral detection and fiber optic signal delivery systems, these recent advances suggest that the time is right for the development of a portable LIBS system for field use.

PHASE I: The Phase I work would develop, and deliver to the Army, a simple first-generation LIBS system prototype capable of detecting Pb in firing ranges as well as in paint contained in various types of military buildings. The requirements for this prototype include hand-held operation and laser beam delivery via an optical fiber wand. This sensor will have to detect Pb concentrations in the ppm range and be interference free.

PHASE II: In Phase II, a second-generation multi-element prototype LIBS sensor would be developed and delivered to the Army. For this unit, optimal laser wavelength over the near-IR to UV spectral range and the optimal detector

configurations between array detectors and acousto-optic tunable filters would be determined. This prototype would be capable of detecting all of the metals listed above, deploy an advanced chemometric system for rapid and specific analyte determination, and have an operating life greater than 500 hours before service.

POTENTIAL COMMERCIAL MARKET: There is an acute need for the characterization of sites of environmental contamination, both military and civilian. Therefore, the worldwide commercial market for portable sensors for toxic metal environmental contamination is significant. This technology would also be useful in the monitoring of toxic metal release during waste combustion.

A95-103 TITLE: Computational Fluid Dynamics of Complex Three-Dimensional Multiphase Flowfields

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is directed towards developing aerosol and vapor phase chemical/biological agent concentrations, complex flow patterns, and in-situ destruction (reaction, bulk break-up or agglomeration) due to shock, aerodynamic pressure, temperature, and chemical reactions in enclosed structures and at the exhaust ventilation openings or under high kinetic energy conditions from a missile impact. The model shall provide a predictive capability of potential collateral toxic effects from the release of chemical and biological agent materials.

DESCRIPTION: The requirements for counter-proliferation and theater missile defense has necessitated the development of a productive mass transport model of hazardous materials related to post engagement events for the neutralization of chemical and biological agent production and storage facilities or a missile-to-missile intercept. The mass transport model shall be employed to minimize the potential collateral toxic effects from the release of chemical and biological agent materials in the facility and the surrounding environment.

PHASE I: Develop the framework for an ab initio computational model to predict the in-situ destruction and the diffusion and convective mass transport characteristics of solid phase and/or liquid phase particulate material and vapor phase material in an enclosed environment employing air handling systems or an open atmosphere environment as in missile-to-missile intercept scenario. The framework shall include, but not be limited to, numerics (3D finite-volume discretization; fully implicit source terms; boundary conditions), grid features (dynamic gridding, grid patching of complex geometries, solution-adaptive gridding), thermochemistry, multiphase flowfields, mass transfer, heat transfer, and turbulence.

PHASE II: Continue improvements on an ab initio computational model to predict the in-situ destruction and the diffusion and convective mass transport characteristics of solid phase and/or liquid phase particulate material and vapor phase material in an enclosed environment employing air handling systems. Additionally, the proposed model shall be validated by comparing the executed code output to the available test data under diversified initial input conditions.

POTENTIAL COMMERCIAL MARKET: For use as a hazard prediction tool in chemical and biological processing production facilities. Additional use in the improved design of air handling systems and air filtration systems in hospitals or high security areas to mitigate transport of infectious diseases or toxins.

A95-104 TITLE: Rapid Ammunition Barricade Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a rapid, low cost, technology to build substantial barricades in remote areas which does not require heavy construction equipment or significant labor resources and uses construction materials of minimal or negligible weight and volume.

DESCRIPTION: The shift in U.S. national military strategy from forward deployed forces to continental U.S. based forces has intensified the need to develop a technology for the building of quick and inexpensive barricades to protect troops and supplies from enemy attack during early entry operations. In addition to providing protection from enemy fire, these barricades are needed to prevent explosive propagation between vulnerable ammunition stacks. Without barricade protection, explosive propagation could result in the loss of substantial ammunition supplies. Recent studies have highlighted the critical and vital strategic importance of protecting these ammunition supplies during early entry operations. Troops and supplies for early entry operations are typically inserted using Air Force cargo aircraft. The ability to transport heavy equipment and building materials for barricade construction is nearly non -existent, due to the need to transport higher priority supplies such as weapons, vehicles, and ammunition.

The U.S. Army's growing involvement in operations other than war, such as flood control and hurricane relief, has also created an increased need for the development of technologies to rapidly build barricades. During these emergency operations, the typical method used to control flooding is to build sandbag walls. This is very labor intensive and time consuming. An improved method to build barricades would substantially enhance the Army's effectiveness during these operations.

To effectively prevent ballistic penetration and explosive propagation, the barricades developed must have substantial weight and density, such as that provided by water or soil. To reduce the amount of material which has to be air transported, the technology developed to build barricades should make maximum use of locally available resources such as water, soil, or sand, to comprise the barricade's bulk. The construction method should make maximum use of readily available lightweight Army equipment such as generators and pumps. Typical dimensions for these barricades is 3 - 6 feet wide, 6-12 feet high, and approximately 20 feet long, however this may be flexible. Examples of technologies which might be considered include expandable water filled bladders, phase change and lightweight, and high strength materials.

PHASE I: Investigate new and innovative technologies for the field construction of rapid barricades. Conduct initial testing to determine if critical design requirements, such as stability, strength, and speed of construction are achievable. Conduct marketing survey to determine commercial potential.

PHASE II: Design and develop full scale prototypes of a rapid barricade. Perform full scale operational and technical testing to determine if the technology developed meets all requirements and is acceptable to potential military users.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be utilized in a variety of commercial applications. It can be used for environmental restoration projects, erosion control, flood control, earth embankment revetments, highway sound barriers, barricades to stop rocks and boulders from falling on highways, and to control the dangers of blasting during civilian construction projects.

Cost Reduction: The ability to construct barricades without heavy equipment and with greatly decreased labor resources will provide substantial cost and labor reductions. This technology leveraging will allow a future smaller force to perform work which previously required many troops and expensive heavy equipment. This cost savings will be realized during future flood control, early entry, and medium regional conflicts.

A95-105 TITLE: Novel Lightweight Desalination Systems for Drinking Water

CATEGORY: Exploratory Development

OBJECTIVE: To develop a small lightweight, handheld, manual device for the individual soldier to desalt seawater for drinking.

DESCRIPTION: The device to be designed will be capable of removing pathogens, suspended materials and dissolved solids from fresh, brackish and salt water to provide one liter of drinking water per day for the individual soldier. The unit must be capable of being transported and operated by one person.

PHASE I: The Phase I program would consist of surveying the present and new technologies and conducting preliminary tests to select a technique for further development. Sub-systems would be selected and laboratory tested ending with a breadboard to prove feasibility.

PHASE II: During Phase II, the selected technology would be developed into a working system by designing, building and testing a prototype. The prototype must produce water that meets the water quality standards for drinking water and meet the military requirements for human factors, safety, and maintenance.

POTENTIAL COMMERCIAL MARKET: Lightweight desalination systems would have commercial application for providing safe drinking water for leisure activities as well as survival in emergency situations as in life rafts and small boats.

A95-106 TITLE: Real-Time Monitoring System for Trace Chemical Vapors During Open Burning/Open Detonation (OB/OD)

CATEGORY: Exploratory Development

OBJECTIVE: To develop a real-time monitoring system for trace chemical vapors that may be emitted from OB/OD of energetic materials.

DESCRIPTION: OB/OD provided a primary means of destroying or treating waste munitions. Although historical records indicate these to be safe and efficient methods, increased environmental awareness is generating data requirements which exceed

the capabilities of current data collection technology. An example is the need for data to support permits submitted under provisions of the Resource Conservation and Recovery Act (RCRA) (Subpart X). Many prime target analyses requires detection at the parts-per-billion level, or lower. To acquire and provide this data in an efficient manner, technology needs to be developed that can provide for monitoring of trace chemical vapors at the part-per-trillion level in real-time.

PHASE I: Identify appropriate existing chemical or physical sensing mechanisms. Develop methodology for design implementation and evaluation of prototype system.

PHASE II: Build the prototype system. The prototype system will be tested at the U.S. Army Dugway Proving Ground Propellent, Explosive, Pyrotechnic Thermal Treatment Evaluation and Test Facility.

POTENTIAL COMMERCIAL MARKET: In addition to the RCRA applications, which apply to both private and public sectors, this technology has great utility in the work place and hazardous waste sites for monitoring of hazardous vapors. It could also be used in airports and cargo holds of ships for monitoring of explosives and narcotics.

A95-107 TITLE: Microwave Applicator for Paint Stripping

CATEGORY: Engineering Development

OBJECTIVE: The objective is to develop a microwave applicator device which will provide concentrated energy to strip paint from composites, wood, and steel substrates. This system should be portable and operate safely during the removal of paint. The structures from which paint needs to be removed include helicopters, aircraft, ships, buildings and bridges.

DESCRIPTION: In the paint stripping processes, by blasting and chemical stripping, hazardous dust and chemicals are produced. Microwave energy can be used with or without a susceptor material to heat the organic paint in order for the paint to be stripped easily. Susceptor materials interact with the microwaves and can reduce the heating time required to strip the paint.

PHASE I: Develop the design concepts necessary to produce concentrated microwave energy at the paint interface. Safety switches and sensors should be used so that the device is safe to operate in the presence of workers and occupants. Design criteria should include the use of susceptor materials if they are needed.

PHASE II: Develop a prototype microwave applicator device. Field test the device on aircraft composites, and wooden structures.

POTENTIAL COMMERCIAL MARKET: Should a reliable and safe microwave applicator be developed, many aircraft and buildings can use this device for paint removal. A very large market exists for a proven paint stripping system which is simple to operate.

A95-108 TITLE: Topographic Technology Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: Research and establish procedures, review existing and potential standards and data resources, and determine average time for throughput in the creation of a standardized value-added data set that links to Defense Mapping Agency (DMA) VPF-based, very large scale vector map product, VMap 3 (aka UVMap). Develop case study for these procedures and evaluate feasibility.

DESCRIPTION: Studies have shown that there is a target audience in need of very highly detailed feature data sets, particularly in the urban environment. This audience will increase significantly as Army moves forward with digitization (Force 21), right-sizing, and Force Projection plans. This project would determine the baseline SOP's production requirements and quality control methodologies necessary for Army facilities to generate value-added feature and attribute coverages to overlay DMA's standard urban vector map product, VMap 3. Value-added coverages would have to be compatible with Topographic Engineering Center developed software that perform statistical checks on data completeness, and would have to be acceptable to DMA and Army by adhering to established standards as well as map coverage and data storage requirements. Concurrently, the coverages must maintain the look and feel of the VMap3 product and other products commonly used by Army in battlefield environments.

PHASE I: Research completeness of VMAP3 prototype, Army SOF and M&S requirements for very highly detailed data, map production requirements in Army facilities, data resources available for value-adding use, and DMA's standards; from these efforts, establish implementation plan for value-added concept, selecting a feasible case study site for which VMap3 or comparable alternative is available

PHASE II: Perform and monitor case study, creating value-adding coverages in mock situation of choice (either

standard or crisis production scheme). Assess coverages' quality, suitability for Army and civil use, and adherence to VPF and production standards. perform post-study evaluation of concept and make recommendations for improvements and implementation in Army Force 21 environment.

POTENTIAL COMMERCIAL MARKET: The ability to provide information to standard mapping products has potential in both Army and civilian uses, to include simulation of urban combat, mission planning and rehearsal, training for urban evacuation procedures, natural disaster preparedness, and civil unrest control.

A95-109 TITLE: A Time-Dependent Non-Linear Free-Surface Wave Simulator for Military Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate a three-dimensional (3-D) water surface, time-series model of a high-order of accuracy that would allow determination of the complex hydrodynamics of nearshore waves for navigation, vessel control, mooring dynamics, harbor tranquility, and tracking of free or loosely- tethered objects.

DESCRIPTION: Effects of boundaries and bottom topography on gravity waves in deep water are minimal and, thus, idealized and simple frequency-domain or spectral wave models may be used to characterize design conditions. In the nearshore region where the Army has a military interest, time-dependent wave models are necessary since nonlinear processes nearshore strongly influence the propagation of waves. Accurate and realistic wave simulation may be obtained with time-dependent models if nonlinearities are included. The Green-Naghdi (GN), Boussinesq, and Volume of Fluid (VOF) theories are particularly well-suited to nonlinear shallow-water wave modeling, although the GN approach is not subject to the limitations other wave theories have in depths less than five wavelengths. With user-friendly interfaces, a model built from one of these theories would allow field commanders to obtain accurate wave estimates necessary to plan and schedule military and civil operations. The general availability of this technology would enhance decision making of leaders, resulting in safer and more efficient operations such as amphibious landings, harbor design, vessel safety and maneuvering in mine-restricted waters, ship mooring and berthing, mine tracking, dredging, and surface-drifting oil spills.

PHASE I: Investigate the suitability of the three above mentioned time-dependent, nonlinear water wave theories for developing a new 3-D shallow-water wave simulation system. Incorporate important nonlinear processes. Design a flexible wave simulation system that allows time-dependent input/output and post -processing. Develop a base model and demonstrate the features on the system using environmental and climatology data at Camp Pendelton and Camp LeJeune (used for amphibious exercises).

PHASE II: Extend the theory and numerics of the military wave simulator developed and tested in Phase I to the prediction of wave effects inside harbors for evaluating mooring and berthing of ships, and for particle tracking of the floating or free- moving objects at the surface of the sea. Incorporate wave breaking, diffraction from surface-piercing structures, and wave- current interaction. Integrate with a graphical user interface (GUI) to facilitate its use by military commanders and others no expert in ocean sciences.

POTENTIAL COMMERCIAL MARKET: The technology will be versatile and my be directly used in several commercial applications such as planning and prediction of wave climatology by the port and harbor authorities responsible for commercial shipping, trafficking, and safety of maritime vessels, and on- and off-loading of the cargo ships offshore and in the ports; contingency planning, remedial and cleanup, of oil spill operations by private companies, Federal and state agencies in open sea or near coastlines; and dredging and construction in the coastal waters by the military and civilians.

A95-110 TITLE: Geographical Information System (GIS) for Marine Operations

CATEGORY: Advanced Development

OBJECTIVE: To develop a PC-based GIS that will provide environmental information to assist in planning and scheduling coastal marine operations such as Logistics Over The Shore (LOTS), dredging, oil spill cleanup or construction projects exposed to the wave environment. The system will include both forecasted and historical environmental information presented in a graphical user interface (GUI) which can by used by personnel who are not experts in coastal engineering.

DESCRIPTION: A comprehensive set of coastal environmental data is a requirement in planning and scheduling any coastal marine operation. A methodology for " Real-Time Forecasting" (RTF) is needed to allow field commanders to predict wave conditions at a site and to evaluate historical data. The RTF will provide considerable enhancements to the existing knowledge

and will provide more informed decision making and result in safer, more efficient operations. Historical databases will include information on beach characteristics, weather, water waves, currents, and water levels. Forecast information will include winds, waves and water levels. The system will include numerical modeling of waves, water levels, and currents. All information will have a geographic reference and will be presented on a "digital nautical chart."

PHASE I: Evaluate the capabilities of current hardware and software related to project needs. Determine all data sources required. Design basic structure of the system including presentation methods based on consultations with the user community.

PHASE II: Develop a GIS to be displayed on a digital nautical chart, including acquisition of hardware and software, and system integration. Included during this phase will be testing and demonstration of the system during military and commercial marine operations.

POTENTIAL COMMERCIAL MARKET: The information system developed will be used by the DOD in LOTS and amphibious operations and by private companies responsible for dredging, oil spill management, share stabilization engineering, and construction in coastal areas.

A95-111 TITLE: Diagnostics System for Antenna Drive Motors and Bearings

CATEGORY: Exploratory Development

OBJECTIVE: To design and test a system to allow for early diagnostics of antenna drive system and associated bearing wear problems.

DESCRIPTION: ALTAIR's drive system consists of five 150 hp DC motors which are coupled to the drive pinions in both azimuth and elevation through Falk reduction gear boxes. The antenna rides on 16 wheels, mounted in four pivoting wheel "bogies". Including the elevation axis bearings and the pintle bearing, there are 59 major bearings. Noise and/or vibration data can be taken to generate a frequency spectrum signature for the gear boxes and the bearings. Changes in the spectrum could flag potential problems before a failure occurs.

PHASE I: Investigate best methods for generating frequency spectrum signature of drive components. Contribution of lube pump and air blower noise and vibration must be determined as filtering may be required. Install sensors and take data for evaluation purposes. Determine the types of degradation's and failures that can be detected by analyzing the spectral signatures of the drive components.

PHASE II: Install vibration sensors on all drive components and bearing locations and route through multiplexed for selective monitoring at the antenna console. Generate characteristic signatures for each component and establish historical data base.

POTENTIAL COMMERCIAL MARKET: Additional markets could include other DoD Spacetrack radar sites, air traffic control radars, weather radars, or other sensors that operate on a 24 hour per day basis and can not be easily monitored for hardware degradation. The techniques developed could be adapted to provide realtime diagnostics for large structures, such as bridges.

A95-112 TITLE: Low-Cost Mission Intensity Analyzer

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low-cost mission intensity analyzer for military air and ground vehicles which correlates actual vehicle usage with component damage rates to enable savings through rational timing of maintenance operations and component replacement.

DESCRIPTION: Maintenance service intervals are typically based on assumed extreme operating conditions. Determination of actual operating conditions will enable component specific servicing or replacement on an as-needed basis. The costliest and least reliable part of structural usage monitoring systems in military vehicles is the integration of instrumentation required to determine loads. Using GPS and other self-contained sensors, it is possible to develop a stand-alone system of sufficient precision to describe various mission segments and quantify structural usage in terms of effective usage hours or miles. This project will demonstrate that the necessary logic and hardware can be implemented at a cost near $3000 using commercial digital electronics.

PHASE I: In this phase a system will be developed and tested for vehicles which operate with virtually full trajectory

alignment (vehicles with zero transverse velocities). This condition holds true for ground vehicles and fixed wing aircraft under most conditions. The structural usage logic will be based on reports of ongoing work in the Army Research Laboratory's (ARL) Vehicle Structures Directorate (VSD) and is limited to one structural part (wing box or chassis). Demonstration of the concept can be performed either on a ground vehicle or a light aircraft and should be capable od discerning between conservative and abusive operation.

PHASE II: Phase II will extend logic to include vehicles whose alignment is not necessarily aligned with trajectory; specifically addressing the situation encountered with helicopters. These systems must have the computational capacity to assess usage for up to 20 parts or subsystems. In this more mature system, self-diagnostics and fail-safe features are desired. The emphasis will be on low cost implementation. Again, most logic will be derived from reports of ongoing work in the ARL VSD.

POTENTIAL COMMERCIAL MARKET: Commercial helicopters, trucks, and trains can all benefit from an affordable mission analyzer that bases maintenance intervals on actual usage instead of predetermined values.

A95-113 TITLE: Navier-Stokes Computational Fluid Dynamics Methodology for Dynamic Stall Calculations

CATEGORY: Exploratory Development

OBJECTIVE: Develop, validate, and demonstrate a three-dimensional, time- dependent, compressible Navier-Stokes computational fluid dynamics code for prediction of dynamic stall on an oscillating wing at realistic Reynolds and Mach numbers typical of modern helicopter rotorblades. The model developed must utilize advanced turbulence and transition models, as well as dynamic adaptive gridding techniques necessary for the accurate prediction of dynamic stall.

DESCRIPTION: Dynamic stall on the rotorblades of modern helicopters is a major barrier to performance enhancement for these devices. Predicting the onset of dynamic stall requires the adequate spatial and temporal resolution of the erupting fluid during the incipient separation phase. Dynamic stall is often preceded by the occurrence of a leading edge shock, even at low freestream Mach numbers. The body of previous computations for this flow event shows the necessity for some type of dynamically adaptive grid methodology, to properly resolve the relevant flow features. To perform this type of calculation at realistic freestream Reynolds numbers, advanced transition and turbulence models must be used. In particular, the inclusion of a modern Reynolds-stress transport model is necessary, as a minimum. Development of such a prediction methodology would greatly help the Army in its quest for vibration reduction and performance improvement of modern rotorcraft.

PHASE I: A two-dimensional version of the code will be developed to prove the feasibility of the proposed grid adaptation scheme. This code should be validated by comparison with available two-dimensional experimental data for both the light and deep stall regimes. Investigation of innovative transition and turbulence modeling techniques will occur, although the actual implementation of these schemes may be made in Phase II (with the Phase I goal being the selection of a single candidate scheme).

PHASE II: The two-dimensional code will be expanded to consider full three-dimensional stall, with further refinement and implementation of the transition and turbulence models selected during Phase I. The resulting code will be validated and compared with existing two and three-dimensional dynamic stall data in both light and deep stall. At the conclusion of Phase II the code and a concise users manual will be delivered.

POTENTIAL COMMERCIAL MARKET: The reduction of dynamic stall-induced vibration inherent to modern rotorcraft is necessary if these devices are to become a viable part of the national transportation system. This computational methodology will be a key element in reducing these vibrations. In addition, a viable and validated three-dimensional Navier-Stokes code capable of accurate and efficient prediction of unsteady separation will be of great use for a variety of commercial applications, including the commercial aerospace and automotive industries.

A95-114 TITLE: Transmission of Information Through Helicopter Rotating Interface

CATEGORY: Exploratory Development

OBJECTIVE: To devise a means of reliably and affordably transmitting information to the rotating system of a helicopter from the fixed system and vice versa.

DESCRIPTION: Current methods of transmitting information through helicopter rotating interfaces are not as reliable as desired. Intermittent data dropout and noise are two of the problems which plague helicopter slip ring users. Poor electrical/physical contact and moisture or particle interference contribute to these problems. A means of transmitting

information such as strain gage or pressure transducer voltages, actuator command signals or power signals to the helicopter rotor or to the fixed system as a return or feedback loop, is needed which will sustain a very high level of reliability under all types of conditions. This method must be implementable to a few aircraft or to many aircraft at a cost less than any currently available slip rings. Development of a low-cost, reliable information transmission system would support S&T Thrust #7, Technology for Affordability, as well as Structural Integrity Program objectives.

PHASE I: Select a basic design concept for feasibility study. This concept should allow for rapid transmission of multiple signals through the rotating interface. This effort should include demonstration of the concept and a preliminary design for further validation in Phase II. A final report and final briefing will be delivered to the Government at the Aviation Applied Technology Directorate at Fort Eustis, VA.

PHASE II: Develop a detailed design and fabricate a prototype system based on the selected design concept. Test the prototype system on a helicopter or a simulation platform similar to a helicopter for operational validation. Demonstrate transmission of various types of data through the rotating interface. Design should address protection from electromagnetic interference (EMI) and elements such as moisture and temperature extremes.

POTENTIAL COMMERCIAL MARKET: Considerable cost savings may be realized by introducing an improved, affordable method of information transmission through a rotating helicopter interface. Quality of data and cost of data acquisition may be improved by development of such a system. Potential applications include flight data recorders, structural integrity monitoring, pilot control advancement, and automated blade control.

A95-115 TITLE: Numerically Efficient Rotorcraft Trim and Transient Response

CATEGORY: Exploratory Development

OBJECTIVE: Development of numerically efficient trim and transient response algorithms for comprehensive rotorcraft analyses.

DESCRIPTION: Increasingly sophisticated rotorcraft analyses often result in extremely long run times that are only partially offset by improved computer hardware. Runtimes must be reduced through more efficient computational algorithms. Two algorithm opportunities for substantially improving runtime are including aerodynamics in the Newton-Raphson Jacobian during time marching, and application of the identical-blade concept to computing periodic solutions. Currently, most comprehensive rotorcraft codes compute transient response using an implicit integration scheme; solving a set of nonlinear set of equations at each time step. The equations are usually solved using the Newton-Raphson method, which requires forming the Jacobian of those equations. But in many codes, only structural terms are used in forming the Jacobian, and aerodynamic terms are ignored. The number of Newton-Raphson iterations could be significantly reduced if a means were found to include the aerodynamic terms in the Jacobian, at least in an approximate fashion. Use of the identical blade concept in computing the periodic solution would improve runtime by reducing the number of degrees-of-freedom by a factor is often as large as the number of blades. This concept has been successfully used in conjunction with the harmonic balance algorithm to compute periodic solutions but it has had only. limited use for periodic solutions using the time marching algorithm. The algorithm has been successfully applied in problems where the blades responses are entirely uncoupled, or coupled only through the aerodynamic wake. The algorithm has not yet been applied to models where rotor blades are coupled structurally through motion of the rotor hub, because the algorithm for doing this has not yet been fully developed or tested.

PHASE I: Develop an algorithm for including aerodynamic terms in the Newton-Raphson Jacobian of an implicit time integration scheme in a comprehensive rotorcraft code. Also, develop an algorithm for extending the identical blade concept to computing periodic solutions using time marching. Demonstrate these algorithms with test problems run on the comprehensive rotorcraft code.

PHASE II: Fully implement the algorithmic enhancements in a comprehensive rotorcraft code, and update the code's documentation to reflect the enhancements. Test the updated comprehensive code with a suite of test problems to demonstrate the runtime improvements to check the accuracy of the modified software, and to demonstrate the runtime improvements from the enhancements.

POTENTIAL COMMERCIAL MARKET: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. This software provides finite element comprehensive analysis with improved, numerically efficient trim algorithms. This capability could be applied to all new commercial designs and product improvements reducing time and design and analysis cost.

A95-116 TITLE: Improved Run Data Base for Comprehensive Rotorcraft Analysis Software

CATEGORY: Exploratory Development

OBJECTIVE: Development of an improved run data base for comprehensive rotorcraft analysis software

DESCRIPTION: Comprehensive rotorcraft analysis systems incorporate dynamic behavior from a variety of disciplines in one code, e.g. multi-body dynamics, structural dynamics, control dynamics, aerodynamics and fluid flow dynamics. Such programs tend to be long running, require and produce large amounts of data and are frequently run in stages. Thus, there is a requirement for data storage tailored to the needs of the code that retrieves and deposits data (input data, intermediate data structures, and output results) when it runs. The stored data remains resident on disk files when the code is not in use. Such data storage and the software that manipulates it is called a run data base (RDB). The data in the RDB must be transportable between machines of different architecture. It must not depend on licensed products since some comprehensive rotorcraft analysis software is freely distributed, and the recipients must not be required to acquire a license for the embedded RDB software. The software must be portable. The code must be written in a standards compliant way with a widely available efficient language (e.g., C++). It should be possible for user's to easily create, modify, and delete data structures in the RDB. Thus, a graphical user interface to the data structures which seems natural to the specialists in that discipline is required. The comprehensive code must be able to create, modify, and delete data structures in the RDB. Thus, a library of routines which can be called from comprehensive codes written in FORTRAN, C, and C++ must be produced. Since minimizing run time is of paramount importance for comprehensive programs, the code must be extremely efficient. Since data structures may be accessed within loops, it is important to minimize the time required for access. Furthermore, since many of the models in comprehensive analysis are constructed from sub-models, the RDB must support hierarchical data structures. Finally, the RDB must consist of a variety of data structures supporting the input, run time and output requirements for diverse disciplines.

PHASE I: Design the run data base and demonstrate its interface with a comprehensive rotorcraft analysis code. Produce design documentation.

PHASE II: Implement the run data base design with a comprehensive rotorcraft analysis code. Document the enhanced capabilities of the data base. Test the augmented comprehensive software and demonstrate the enhanced capability over the original code for a suite of test problems.

POTENTIAL COMMERCIAL MARKET: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. This software provides finite element comprehensive analysis with an improved run data base. This capability could be applied to all new commercial designs and product improvements reducing time and design and analysis cost.

A95-117 TITLE: Resolution of Induced and Profile Components of Aerodynamic Drag on Rotors in Hover and in Forward Flight

CATEGORY: Exploratory Development

OBJECTIVE: Establish and demonstrate new and innovative methods for efficient and accurate determination of aerodynamic drag forces acting on rotors in hover and in forward flight. The method developed must be capable of differentiating and individually quantifying the induced and the profile components of the drag force and must form a rational basis for drag reduction investigations.

DESCRIPTION: The problem of drag reduction is central to modern aerodynamic research and is of special importance to rotorcraft technology. A significant reduction in aerodynamic drag acting on rotors in hover and in forward flight can lead to substantial improvements in rotor performance, with corresponding benefits in rotorcraft payload and range capability. A qualitative understanding of various physical processes important to drag has been available for several decades. This understanding suggests that the drag force as well as the moment of the drag force acting on rotor blades can be significantly reduced through improved rotor designs. Unfortunately, this understanding is insufficient for quantifying the relative importance of the various features that are present in rotor flowfields. Experimental rotor aerodynamic data are at the present restricted mostly to total forces, component forces and surface pressures. On such a basis, it is difficult to differentiate the contributions of various flow mechanisms to drag. In particular, the resolution of the total drag into the profile drag and induced drag components is impracticable. The engineer interested in drag reduction must rely upon cut-and-try processes, which are often prohibitively costly and time- consuming, to arrive at desired design compromises. New and more efficient procedures for drag determination that can quantify individually the various contributors to aerodynamic drag on rotors are needed.

PHASE I: The vortical wake method for drag determination shall be established and calibrated for hovering rotors. The available vortical wake method is for steady flows in an inertia reference frame. The hovering rotor flowfield is steady only in a rotating reference frame. The effect of the reference-frame rotation on the wake integrals shall be determined and incorporated into the method. Computer programs shall be developed for the evaluation of the modified vortical wake integrals and of the associated induced and the profile drag components using experimental data for the vortical wake. Available AFDD aerodynamic force and wake data for the hovering rotor shall be utilized for the calibration of the modified method. Exploratory parametric studies shall be carried out to determine the effects of various geometric factors on the induced and the profile drag components.

PHASE II: The vortical wake method for drag determination shall be fully developed and calibrated for rotors in forward flight. The forward-flight rotor flowfield is intrinsically unsteady and the vortical wake integrals shall be derived for general unsteady flows. Computer programs shall be developed for the evaluation of the unsteady vortical wake integrals and of the associated unsteady induced and profile drag components. Forward-flight rotor experiments shall be planned and conducted to obtain vortical wake data as well as force balance data. These data shall be utilized in a thorough calibration of the method for rotors in forward flight. Parametric studies shall be carried out for both the hovering and the forward-flight rotors and design criteria for drag reduction shall be suggested.

POTENTIAL COMMERCIAL MARKET: This technology will have direct applications in the rotorcraft industry. In addition to rotors, the method as well as the data generated in this research are directly applicable to the design of both marine and aircraft propellers. The fully established technology, by creating a practical capability to quantify the induced and the profile drags individually, is expected to have a significant impact on future designs of fixed wing aircraft as well as ground and marine transport systems.

A95-118 TITLE: Actuator/Sensor Arrays for Active Structural Control

CATEGORY: Engineering Development

OBJECTIVE: Design analyze and develop actuator/sensor arrays and associated control algorithms that provide active structural control for vibration suppression, shape control and/or damage detection/control

DESCRIPTION: Recent developments in miniature sensors and actuators and advances in high speed digital data transfer and computation lead to the possibility of real-time integration of structural dynamics with actuator/sensor arrays to achieve active structural control for improved efficiency. These actuators and sensors can be embedded in the material or attached to the surface. Examples of such devices include Micro-electricomechanical systems (MEMS), miniaturized standard instrumentation such as accelerometers, piezoelectric material embedded into composite material and used for both sensing and actuation, and optical fiber sensors. Individual actuators and sensors can be linked together with digital processing to form an actuator/sensor arrays. These arrays could provide spatial distribution of an active control system throughout the structure. Because the actuator/sensor array is spatially distributed, the structural surface deflections can be measured and controlled directly in real-time, with the sensor arrays providing the spatial information needed to define mode shapes and the actuator arrays providing specialized spatial integration of the structure. Enabling technologies include actuator/sensor selection and placement, control algorithms development, and distributed computing capabilities of the array.

PHASE I: Select a suitable problem to demonstrate structural control. Design methodology for increased structural efficiency through active control utilizing actuator/sensor arrays will be developed. Selection of actuator/sensor genre and design alternatives for the selected problem will be made. Control Algorithms will be developed and demonstrated in a laboratory experiment.

PHASE II: Optimize the actuator/sensor arrays for structural efficiency. Extended the laboratory experiment to a complex structure and account for nonlinearity and changes in the environment, allowing for reconfiguration of the arrays to accommodate the changing demands on the distributed computing capabilities of the arrays.

POTENTIAL COMMERCIAL MARKET: Active structural control for vibration suppression and damage detection/control on commercial aircraft using actuation/ sensor arrays has payoffs in reduced operational costs and ride comfort.

A95-119 TITLE: Pressure-Based, Finite Volume, Unstructured, Solution-Adaptive Computational Fluid Dynamics (CFD) Code for Heat Transfer and Pollutant Dispersal

CATEGORY: Advanced Development

OBJECTIVE: Develop a pressure-based, finite volume, unstructed, solution- adaptive computational fluid dynamics (CFD) code for heat transfer and pollutant dispersal. Also, develop a thin wall porosity capability within the code. Efficiently implement on SMP architectures.

DESCRIPTION: The U.S. Army wishes to develop a CFD solver for simulating flow, heat transfer, and pollutant dispersal in and around mission critical electronics, porous battlefield hospital tents and combat vehicles. These computations will involve computing incompressible flow in complex geometrics and the tracking of unsteady pollutant fronts. The complexity of the geometrics involved makes unstructured grids and thin wall porosity necessary. Solution-adaptivity is desirable to resolve flow features of interest. Since the flows involved are incompressible, it is desirable that the solution algorithm be pressure-based. Mixed-mesh topologies are of interest to allow the greatest flexibility in mesh generation. Solution-adaptivity must include not only standard refinement and coarsening schemes involving conformal elements, but also adaption strategies involving hanging nodes for maximum flexibility. All aspects of the solver, including adaption, should be able to take advantage of parallel processing to accelerate the solution of these large unsteady problems. Because of adaption, methods which maintain balanced loads among all processor will be necessary. Efficient implementations on shared-memory symmetric multiprocessor (SMP) architectures are of particular interest. User-friendly pre-and post processing, including CAD geometry modeling tools and automatic mesh generation, are desirable.

PHASE I: Develop steady laminar/turbulent flow and heat transfer capability for hexahedral and tetrahedral meshes with solution-adaptivity using a pressure-based, finite volume, scheme with multispecies capability (pollutant dispersal).

PHASE II: Extend Phase I formulation to include unsteady flow, heat transfer and pollutant transport. Complete parallel processing for SGI Onyx platform and demonstrate code on unsteady, three-dimensional problems of interest to the Army. Train Army personnel in the use of the code.

POTENTIAL COMMERCIAL MARKET: This solver will find widespread use in commercial low-speed flow applications by greatly reducing the time for mesh generation, by optimally deploying mesh points through solution-adaption and by obtaining significant speed-up through parallel processing. The code will be used in the automotive, aerospace, chemical processing, electronics cooling, materials processing industries and in numerous other areas.

A95-120 TITLE: Soldier Mobility Amplification

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate products utilizing mature, as well as emerging, technologies that enhance the individual soldier capabilities in terrain traversal and/or load maneuvering by optimizing and amplifying human-generated energy.

DESCRIPTION: Increased mobility for the infantry soldier means running faster, marching longer, and climbing higher with the necessary stamina to complete the mission. The goal this effort is to provide system concepts to improve the mobility of the dismounted fighter, but without adding the weight and logistical requirements of an external power source. In other words, soldier-powered amplifiers for increased ground mobility. For example, devices that will enhance the soldier's performance through optimizing/directing energy exerted or by adding strength, agility, and/or speed utilizing energy storing material. Any product or device that enhances or amplifies the soldiers ability to traverse the battlefield without external power sources will be considered under this announcement. The realities of the military downsizing and increased mission responsibilities are proving detrimental to the dismounted fighter's ability to maneuver around the battlefield or conduct Operations Other Than War. Today's ground soldier is still carrying upwards of 100 lbs. into situations that may require traversing extreme or difficult terrain. And the weights of these loads are increasing with more and more technology enhancements added to insure lethality, survivability and sustainability.

PHASE I: Identify and explore novel concepts that offer potential of enhancing the soldier's ground mobility performance without external power requirements or significant increases in overall weight and bulk. Submit proposals for technical feasibility and acceptance. Design and develop "breadboard" model(s) of chosen system(s) to prove functionality and bio-mechanical efficiencies.

PHASE II: Optimize the selected Phase I system(s) through refinement of design and/or material changes. Provide

final technical report with full specification for optimized system(s).

POTENTIAL COMMERCIAL MARKET: This technology has many applications in industrial and construction areas.

A95-121 TITLE: Stitchless Textile Fabrication System

CATEGORY: Advanced Development

OBJECTIVE: The objective of this proposal would be to develop a piece of equipment that allows textile materials to be slit, bounded and taped in a single passthrough operation.

DESCRIPTION: Separate commercial technology currently exists for ultrasonic slitting and heat seam taping. Combined, these technologies provide for stitchless hermetically sealed seaming technique for manufacture of textile based clothing, uniforms, tentage, parachutes and other end-item constructions. Advantages of these techniques include self-sealing capability (against all environments), good seam strength (stronger than 2 needle-felled sewn seam), good appearance, and ease of manufacturing; however, its disadvantage is that it requires a two-step operation (ultrasonic slitting followed by seam taping utilizing two separate machines).

PHASE I: Develop prototype equipment that allows for two synthetic based textile pattern pieces in a superimposed position to be either ultrasonic or laser cut or sliced through the pattern layers. Upon emerging either from the Ultrasonic Wheel or laser cutting beam the materials shall exhibit a smooth clean raw edge, that provides bonding strength enough for subsequent handling purposes. The raw edge, through some means of semi-automatic movement system, shall then be transported through a directed heat taping system operated either by hot air, ultrasonics or laser. Upon heating, the adhesive backed tape shall be pressurized sufficiently to allow the hot molten adhesive to penetrate the abutted materials of the pattern pieces. Upon cooling the adhesive cures and provides for a highly effective stitchless seam structure that inherently is self-sealing. The challenge is that the initial cutting conducted in an edge on edge position while the subsequent taping operation is conducted such that the tape (typically one-inch wide) straddles more or less 1/2 inch of each pattern piece while the pattern pieces maintain their adjoined bonded position. End results shall be a visible seam tape on one side of adjoined pattern pieces while just a thin adjoined line of smooth molten materials is visible on the opposite side of the pattern pieces with the line more or less located in the middle of the tape.

PHASE II: Wear test the Phase I equipment for a garment manufacturing evaluation.

- Recommend changes.
- Incorporate changes for finalized equipment manufacture and supply engineering drawings.
- Begin manufacture of equipment for government/commercial utilization.

POTENTIAL COMMERCIAL MARKET: End-item garments in the mens and women's dress, combat, utility and children's wear categories including home care (curtains, upholstery, etc.), automotive, outdoor tentage, awnings, backpacks, parachutes and virtually all currently sewn textile markets could potentially be constructed using such state-of-the-art equipment. All seams would be self-sealed, provide excellent seam strength, excellent appearance, and hasten end-item production, lower costs, provide better quality and open the path to a complete automation manufacturing system.

References:

1. Bi-monthly/final reports, Clemson University, Contract DAAK60-89-C-1070 "Development of Stitchless Chemical Protective Uniform". Video final report (VHS), Clemson University same contract. US Army Natick RD&E Center, various fabricated uniforms, samples, tape and fabric of same contract.

A95-122 TITLE: Intelligent Sensor-Based Robotic Control System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems to be used in ammunition handling, resupply and logistics applications.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor-based servo control systems for high performance robotic manipulators. Specifically, a high speed 80386-based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to

deal with fundamental problems of mobility and base motion effects, flexible task level control, multi- sensor integration, multi-manipulator coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunitions to and from resupply vehicle and loading ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control for kinematically redundant robotic manipulators, voice natural language interface for control, multi-manipulator control strategies, world modeling design environment, real time control, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/avoidance and component based software architectures.

PHASE I: Develop methodology and algorithm approaches to intelligent sensor based robotic control systems for applications in materiel handling and loading. Perform preliminary modeling and simulation studies to determine performance/ robustness characteristics of the control laws and algorithms, real time processing requirements and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications. Develop technology commercialization plan.

PHASE II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be utilized on any production line performing product handling, part mating and product transferring applications. Particularly, for the Army, this technology can be used in programs like the Future Armored Resupply Vehicle (FARV-A) and Advanced Field Artillery System (AFAS) to perform ammunition fusing, handling and loading during re-supply operations.

Cost Reduction: This technology will provide cost reductions to Army operations where elimination of operators is needed. For instance, in programs like FARV-A and AFAS, this technology will be beneficial due to its potential application to operations such as fusing, de-palletizing and transferring of ammunition to and from re-supply vehicles.

A95-123 TITLE: Non-Lethal Devices

CATEGORY: Exploratory Development

OBJECTIVE: To design, develop and demonstrate non-lethal devices capable of temporarily incapacitating / immobilizing personnel and materiel targets without lethality, serious injury, or excessive property destruction with dual-use application for law enforcement, or other direct technology transfer to private sector use.

DESCRIPTION: Rules of engagement necessarily restrict the use of deadly force in peacekeeping and humanitarian relief operations. There is a need to fill an intermediate force gap through the development of non-lethal devices / mechanisms that immobilize personnel and vehicles without inflicting casualties and while minimizing collateral damage. These devices are needed to provide non -lethal stand-off and force protection capabilities as well as tactical flexibility. In addition, these devices will simultaneously provide a dual-use, less than lethal capability for law enforcement applications, or direct technology transferability to the commercial sector. Lethal vs. Non-lethal Effects: A critical area for the assessment of non-lethal devices is modeling and simulation based on actual, measurable parameters required to determine their effectiveness. This includes new test methods, bio-simulant effects, simulation models, battlefield effectiveness studies, and effects databases. Battlefield simulation modeling and verification test methods (e.g., against bio-simulant targets) are critical to evaluating the effectiveness and potential field utility of non-lethal devices before committing larger investments of resources.

PHASE I: Design, fabricate, test, and verify effectiveness of non- lethal devices with capability to temporarily incapacitate / immobilize personnel and vehicles. These devices will preferentially be versatile enough to deliver a range of effects from annoyance/discomfort up to lethality, or allow for near instantaneous switching / changeover from non-lethal to lethal from existing weapons platforms. Formulate and demonstrate concepts for specific devices including methodology and/or modeling of utility in peacekeeping and humanitarian assistance operational scenarios. If successful in phase I, there is a good potential for phase II. Initiate development of marketing plans for phase III efforts and identify user interest and potential for dual use applications. Desired Operational/Tactical Capabilities include: 1. Graded Response / Incremental Penalty: Provide a tunable level of incapacitation based on situation / task required. 2. Instantaneous Selection / Switching: Users require near instantaneous changeover from non-lethal to lethal "fire" from the same weapon / delivery platform. 3. Utilization of Existing Logistics Chain: Application to, or minor modification of, existing weapons systems are essential due to declining defense funds, and need to minimize basic load (weight). Highly applicable individual soldier platforms for non-lethal devices are hand-emplaced devices, handguns, batons, grenades (launched, hand-thrown), shotguns, M16 Rifle, machine guns, light mortars, or vehicle mounts.

PHASE II: Develop operable prototypes and conduct tests to evaluate performance against various bio-simulants or vehicle targets of interest. Evaluate reliability & effectiveness using war gaming models and simulated targets. Develop detailed plans for full integration into suitable weapon platforms / delivery vehicles (i.e. weaponization).

POTENTIAL COMMERCIAL MARKET: There is potential to use these devices for law enforcement applications, or for technologies required for successful operation to have direct commercial sector application. Potential for phase III is high. The military will use these items primarily, but not solely, for operations other than war where use of non-lethal force is appropriate to prevent and/or control escalation or to serve as force protection measures.

A95-124 TITLE: Remote Fire Extinguishing System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a remote fire extinguishing system that will enable personnel to put out fires occurring at ammunition storage areas from safe distances and increase soldier survivability.

DESCRIPTION: The operating distances for existing fire extinguishing systems is within a very few feet of the fire, and is very dangerous for firefighting personnel who fight fires at ammunition storage areas. Many times a fire at an ammunition storage site is left to burn itself out resulting in the massive destruction of property, material, and at times the loss of lives. The accident that occurred at Camp Doha, Kuwait after Desert Storm is a good example. A fire resulted in the loss of millions of dollars worth of weapons and ammunition, and the loss of several lives during subsequent cleanup of scattered munitions. That damage could have been prevented if a fire extinguishing system had been available to fight the fire at a safe distance during its early stages. A remote system consisting of a launcher, propulsion device, and projectiles filled with fire extinguishing chemicals could be developed to solve this problem. The technical issues to be considered during the development of a Remote Fire Extinguishing System are: the launcher should be low cost, lightweight and able to withstand the pressures generated from a propulsion device. The propulsion device must be safe to use with the portable launcher and chemically filled projectile, and should launch the projectile at a 20 to 80 degree angle a distance 100 to 1500 feet. The projectiles should maintain their structural integrity during long term storage at the environments that the ammunition is likely to experience, (-60 to +165 degrees F) and should not release its fire extinguishing cargo until over the fire or at impact. The fire extinguishing chemicals must meet all environmental requirements, and should be capable of extinguishing all types (wood, plastic, petroleum, propellant, etc.) of fire that could occur in an ammunition storage area.

PHASE I: Investigate new and innovative chemicals that can effectively extinguish fires that occur in ammunition storage areas. Design a projectile to allow for proper release of the fire extinguishing chemicals and withstand launch forces. Investigate the type of propulsion devices available that generate sufficient energy to launch the projectile safely. Develop a launcher that is low cost, lightweight, reusable, and is portable by one person. Develop a system design that integrates the launcher, propulsion device, and projectile as a Remote Fire Extinguishing System.

PHASE II: Develop test hardware and test plans for the Remote Fire Extinguishing System components (launcher, propulsion device, and projectile) and the total system. Fabricate prototype test hardware, conduct testing of the prototype, and provide a final report that includes component specifications, unit cost, and test results.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program may be utilized in any commercial explosive, fuel, and other hazardous material storage areas. The system will enable personnel to put out fires from a safe distance and prevent the loss of lives and property.

Cost Reduction: A major fire in an ammunition storage area could mean the loss of lives, property, and supplies. The Army cannot afford to lose anything critical, especially during combat situations. This technology will provide safety to Army personnel, preventing the loss of lives, ammunition, supplies, weapons, and maybe even the battle.

A95-125 TITLE: Advanced Nonlinear and Hybrid Systems Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate high-performance nonlinear, adaptive, and hybrid systems control technology for precision multi-target/ multi-platform fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital processing together with LQG/LTR and H-infinity design approaches. Further

improvements in weapon accuracy and targeting performance are anticipated through the development of improved robust nonlinear and adaptive control laws, and hybrid control laws that account for both continuous as well as logical components of the system state vector. This project will address the broad spectrum of issues associated with the development of control law design tools and methodology, modeling, simulation, and real time hardware/software implementation,

PHASE I: Develop methodology for design and implementation of high performance robust adaptive, nonlinear and hybrid system control laws for precision weapon stabilization, tracking and targeting. Formulate specific stabilization, tracking and targeting control laws/ decision strategies for multi-input, multi-output nonlinear plants, incorporating distributed smart sensor/actuators, along with friction, backlash, resonant modes, high impulse periodic disturbances, nonlinear compliance, sensor noise, and multi-target sensor input. Determine performance and robustness characteristics with respect to model errors associated with both continuous and logical components of the domain model. Provide analysis of hardware/software implementation requirements to achieve real time performance.

PHASE II: Develop a fully integrated design and prototyping environment for advanced nonlinear, adaptive and hybrid control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

POTENTIAL COMMERCIAL MARKET: This work has a very high probability of being commercialized. The methodology, design environment, and prototyping tools developed in this SBIR are applicable to manufacturing, machine tool, process control, and automation applications, including automobile and commercial aircraft manufacturing, robotics applications, precision instrumentation systems, flight controls etc. These applications are characterized by the presence of nonlinearities, parameter variations, backlash, friction and resonant modes, while large scale automation requires consideration of hybrid discrete event and continuous time system dynamics.

A95-126 TITLE: <u>6-DOF Isolation and Excitation Facility</u>

CATEGORY: Advanced Development

OBJECTIVE: To develop a six degree-of-freedom (DOF) test and development facility that isolates and excites, in a precisely controlled manner, payloads and/or instruments whose mass may range from 1 kg up to 1000 kg.

DESCRIPTION: Tactical military hardware is typically tested and evaluated to ensure proper operation in their anticipated service environments. Precise excitation and measurements are vital in the test process. Presently, these tests and measurements are conducted with the use of electro-mechanical or electro-hydraulic actuators which inherently produce severe cross-coupling between axes. It is desired to develop a 6-DOF vibration excitation platform capable of precisely duplicating field level dynamics while minimizing the unwanted cross-coupling characteristic of classical mechanically-coupled test platforms. A need exists to develop and implement new innovative approaches to overcome present limitations. Payload and/or instrumentation masses may vary from 1 to 1000 kg, and their sizes may be up to 1 meter by 1 meter. The height is limited only by practical limitations (such as facility ceilings). The minimum stroke requirements are up to 25mm pk-pk (37.5 mm pk-pk desired). Acceleration levels are limited to sinusoidal levels of 5 G's pk and random levels of 5 G-rms. Random vibration shall be capable of producing 3-sigma peak acceleration levels.

PHASE I: Perform a comprehensive literature search and feasibility study of performing 6-DOF motion simulation via a magnetically levitated test platform. Generate detailed design of required test facility which will meet the stated test and evaluation criteria. A detailed report of the investigation shall be provided at the completion of the study. The final report shall contain a detailed outline of the research findings and a proposed solution and implementation plan. The proposal shall include both mechanical and control solution candidates.

PHASE II: Implement a functional prototype at the Dynamic Test Branch, Redstone Technical Test Center, Redstone Arsenal, AL. The prototype shall be a fully-functional 6-DOF test platform, including all related control hardware and software required to perform closed loop motion simulation.

POTENTIAL COMMERCIAL MARKET: Wide bandwidth 6-DOF excitation or motion simulation platforms have been a long-term goal of both the military and commercial shock and vibration communities. Current mechanically-coupled options have multiple limitations resulting primarily from mechanical cross-coupling effects. If 6-DOF excitation via a magnetically levitated test platform proves feasible, there will be a strong potential commercial market for such an alternative technology.

NAVY
Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-8528

All SBIR proposals should be submitted to the above address and must be received by the date and time indicated in Section 6.2 "Deadline Of Proposal" appearing in the front part of this DOD solicitation.

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy primarily through science and technology dual-use, critical technology topics. A total of 31 Science and Technology (S&T) areas has been identified (see Table 1). While all of these areas may not be funded equally during the annual DOD SBIR solicitations in which the Navy participates, topics will be funded according to a priority it has established to meet its mission goals and responsibilities.

This solicitation contains a mix topics. Please read the information contained in the front portion of this solicitation carefully before sending your proposal. The Navy's part of the solicitation contains topics which permit latitude for small businesses to submit their solutions to Navy requirements and will be on the INTERNET under ONR or ONR Homepage. We are attempting to provide proposers the opportunity to send their proposals on diskette for this solicitation. From the ONR Homepage on the INTERNET under the SBIR section you will be able to go to the Navy part of this solicitation and "pull down" into your computer an SBIR format for filling out your SBIR Proposal on disk which could be mailed to the above address together with a single signed hard copy. All proposals sent on disk should be written using one of the following software packages: WordPerfect 5.1, 5.2, 6.0; WordStar 2000 1.0, 2000 2.0, 2000 3.0, 3.3, 3.4, 4.0, 5.0, 6.0, 7.0; MultiMate 4.0; MS Word for Windows 1.0 or 2.0; MS Word 4.0 or 5.0; or Display Write 4.0 or 5.0. However, unlike the solicitation on the INTERNET under the Defense Technical Information Center (DTIC) you will not be able to ask questions. Any questions you want to ask must come through the INTERNET under DTIC SBIR Solicitation. A listing of selections for awards for the Navy SBIR solicitation will be listed on the INTERNET under DTIC and Navy Homepages.

When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of successful Phase I effort will be eligible for a Phase II award. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office for proper processing. Phase III efforts should be reported to the SBIR program office noted above.

As in the past solicitation the Navy will provide potential awardees the opportunity to reduce the gap between Phases I & II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. The Phase I Option should be the initiation of the demonstration phase of the SBIR project (i.e. initial part of Phase II). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formally called "a commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II option will be limited to 40 pages. The transition plan should be in a separate document.

Evaluation of proposals to the Navy will be accomplished using scientific review criteria. Selection of Phase I proposals will

be based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY	SCIENCE
Aerospace Propulsion and Power	Computer Sciences
Aerospace Vehicles	Mathematics
Chemical and Biological Defense	Cognitive and Neural Sciences
Command, Control, and Communications	Biology and Medicine
Computers	Terrestrial Sciences
Conventional Weapons	Atmospheric and Space Science
Electron Devices	Ocean Science
Electronic Warfare	Chemistry
Environmental Quality and Civil Engineering	Physics
Human-System Interfaces	Electronics
Manpower and Personnel	Materials
Materials and Structures	Mechanics
Medical	Environmental Science
Sensors	Manufacturing Science
Surface/Undersurface Vehicles	
Software	
Training Systems	

NAVY SBIR PROGRAM MANAGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT	PHONE
068-076, 078, 081-097 and 099-101	Mr. Douglas Harry	703-696-4286
102-106	Mr. Joseph Johnson	703-640-4801
107-121	Ms. Betty Geesey	703-696-6902
122, and 157-163	Mr. Eugene (Gene) Patno	805-989-9209
125, 126, 132, 134, 147, 151-153, and 156	Ms. Carol Van Wyk	215-441-2375
123, 127-129, 135-140, 145, 146, and 148-150	Ms. Cathy Nodgaard	703-604-2437 x6309
077, 124	Mr. Ed Linsenmeyer	904-234-4161
130, 141, 173, 197, and 198	Ms. Beth Klapach	301-743-4953
131 and 133	Mr. Charles (Chuck) Sullivan	317-353-7998
142 and 223	Ms. Janet Wisenford	407-380-8276
143, 144, 179, 180 and 194	Ms. Patricia (Pat) Schaefer	202-767-6263
154 and 155	Mr. Peter (Pete) O'Donnell	908-323-7566
164, 166, 167, 169, 171, 172, 174, 176, 177, 181, 186, 209, and 211	Mr. William (Bill) White	703-602-3002
165, 170, 182 and 187-190	Mr. Frank Halsall	301-227-1094
080, 098, 168, 175, 178, 183-185 191, 204, 210 and 219-221	Mr. Donald (Don) Wilson	301-394-1279
192, 193, 195, 196 and 199-203	Mr. Jim Linn	812-854-1352
79, 205-208 and 212	Mr. John (Jack) Griffin	203-440-4116
213-215	Lcdr Paul Knechtges	301-295-0885
216-218	Ms. Linda Whittington	703-607-1648
222 and 224	Dr. Meryl Baker	619-553-7681
225-227	Mr. Nicholas (Nick) Olah	805-982-1089

SUBJECT/WORD INDEX

SUBJECT/WORD | TOPIC NO.

DEPARTMENT OF THE NAVY
SBIR 95.3 SOLICITATION TOPIC TITLES

N95-068	User-interfaces for Rule-Based Formal-Methods Environments
N95-069	Uncertain Data in Information Engineering
N95-070	High Power Electronics
N95-071	Gallium Nitride (GaN) Based Blue-Green Emitters on Silicon-on-Insulator (SOI) Substrates
N95-072	Optoelectronic Signal/Image Processing for C3I Applications
N95-073	Ultra-High Isolation Circulator/Duplexer for Advanced C^4 I
N95-074	Underwater Autonomous Power Generation
N95-075	Inertial Navigator on a Chip
N95-076	Data Management and Satellite Relay for Environmental Research Aircraft
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N95-084	Innovative Repair/Maintenance Materials for Navy Piers and Wharves
N95-085	Explosions of Particle Clouds Comprised of Reactive High Temperature Materials in Air
N95-086	CFD Code for Surface Pressure Fluctuations
N95-087	Improvements to Naval Ship Engines Through Water Addition
N95-088	Actuators and Sensors Placement for Active Control
N95-089	Simulation of Fracture in Fluid Structural Interaction
N95-090	Parametric Analysis of Naval Ship Systems
N95-091	Near-Infrared Fluorophores for Advanced Array Biosensors
N95-092	A Rapid In Vitro Diagnostic Kit to Detect and Identify Interferon-alpha in Patient Fluid Samples
N95-093	Biofilters for Reduction of Gaseous Emissions

N95-094	Haptic Interface Technology for Telerobotics and Virtual Reality
N95-095	Man-Machine Interface to Integrated Mechanical Diagnostics Systems
N95-096	A Communication System for Analog and Digital Neural VLSI Microchips and Boards
N95-097	Nonacoustic Sensors of Sliding Contact Mechanical Properties
N95-098	Ductile-to-Brittle Transition in Molybdenum Disilicide ($MoSi_2$) and Related Materials
N95-099	Spatial Geometric Analysis Systems
N95-100	Digital Assistant Technology
N95-101	Solid Free-form Fabrication
N95-102	Lightweight Surveillance Radar Technology
N95-103	Low Cost, High Waterspeed Obstacle Detection System
N95-104	Portable Environmental Control System (PECS)
N95-105	High Temperature Corrosion Resistant Coatings
N95-106	Radio Frequency Information Dissemination
N95-107	Data Link Training and Exercise Coupler
N95-108	Quantification of Platform Level Mission Effectiveness
N95-109	Milstar MDR - Network Bridge
N95-110	Demodulation of Signals Localized by Super-resolution Array Processing Techniques
N95-111	Multiple, High Bandwidth Light Weight Satellite Communications (SATCOM) Antenna
N95-112	Graphic CASE Tools for INFOSEC Threat and Risk Analysis
N95-113	Coarse-Grained Parallel Desktop Computing System for Enhanced Image Processing
N95-114	Virtual Information Model (VIM)
N95-115	Expert System Tactics Representation
N95-116	Global Positioning System (GPS) Integrity Monitoring
N95-117	Advanced System Trainer
N95-118	Advanced Signal and Image Processing Algorithms for Parallel Desktop Computing
N95-119	Increased Data Throughput on EHF SATCOM
N95-120	Single Channel Acoustic Broadband Classification
N95-121	Multi-Band Radar for Ocean Characterization

N95-122	Frequency Domain GPS Receiver
N95-123	32-Bit High Throughput Processor/Emulator Chip
N95-124	Innovative Solid-state Blue or Blue-Green Laser
N95-125	Radar-Sonar Data Fusion for Clutter Suppression Improvements in Shallow Water Submarine Detection and Classification Performance
N95-126	Rugged CD-ROM Optical Disk Drive
N95-127	Ultra High Speed Processor
N95-128	Adaptive Beamforming for Mutistatic Active Sonar
N95-129	Expendable Small Object Avoidance (SOA) Sonar Detector
N95-130	Fault-Tolerant Navy Tactical Data Processing
N95-131	Digital Voice Signal Distribution for Crew Communication
N95-132	Corrosion Preventive Compounds or Preservative with Lower Volatile Organic Compound Content
N95-133	Integrated Product Data Environment
N95-134	Recycling of Cured Composite
N95-135	Adhesive Bond Integrity of Composites
N95-136	Ultrahigh Fidelity Inspection of Advance Composite Materials
N95-137	Wearable Electronics for Man Machine Interface
N95-138	Realistic Correlated Infrared Sensor Scene Generation
N95-139	Realistic Correlated SAR Scene Generation
N95-140	Unmanned Aerial Vehicles (UAV) Imagery Processing for Geophysical Information System (GIS) Applications
N95-141	Effective Retrieval of Human Technical Knowledge
N95-142	Low Cost Image Generator for Mission Rehearsal
N95-143	Cordless Visual Display Technology for Virtual Environment Applications
N95-144	Six Degree of Freedom Tracking Devices for Virtual Environment Applications
N95-145	Thermal Stability Enhancing Additive for JP-5 Fuel
N95-146	Energy Dissipation Characterization and Design Methodology for Composite Materials
N95-147	Water Crash Dynamics and Structural Concepts for Naval Helicopters
N95-148	In-Situ Advanced Fiber Placement and Processing

N95-149	Advanced Induction Welding of Composites with Out-of-Plane Reinforcement
N95-150	Composite Material Design and Manufacturing Assessment for Advanced Navy Aircraft and Missile Systems
N95-151	Test and Evaluation Tool for Calibration and Dynamic Testing of Manikin Systems
N95-152	Reflective Coating for Aircrew Helmets
N95-153	CFD Analysis of Rocket Plume Effects on Ejection Seat Aerodynamics
N95-154	Day/Night Ship Mounted Aircraft Approach and Landing Imaging Sensor
N95-155	Electric Energy Absorber System (EEAS) for Aircraft Recovery
N95-156	Anti-Reflective Coatings for Aviation Helmet Visors
N95-157	Compact, High Power, Quick Reacting Storable Energy Sources.
N95-158	Modeling Characteristics for Volumetric Explosives
N95-159	High Energy Density Fuels for Solid Fuel Air Explosives (FAE)
N95-160	Passive Techniques To Eliminate Combustion Instabilities
N95-161	Pulse Width Modulated Valves for Liquid Fuel Control
N95-162	Weapons Quality Q-switched Laser
N95-163	3-Dimensional Perspective Transformer at Video Rates
N95-164	Develop Test Concepts and Techniques to Quantify the Free Field Safety Level of RF Induced Body Currents and RF Burn in Humans
N95-165	Develop and Produce a Real-Time Ultrasonic Weld Evaluation System
N95-166	Universal Portable Communicator
N95-167	Develop System for Gas Turbine Duct Noise Cancellation
N95-168	Develop a Low Cost Fiber Optic Switch
N95-169	Magnetic Bearing Shock
N95-170	Develop Electric Starter Motors for Ship Propulsion Gas Turbine
N95-171	Develop Improved Electronic Classroom Human Interfaces
N95-172	Develop Improved Solid State Neutron Detector
N95-173	Develop Passivated Pyrophoric Metal Powders
N95-174	Develop a Fuel Fume Environmental Recovery System (FFERS)
N95-175	Develop an Expendable, Gun Launched Observation Vehicle
N95-176	Develop an Expendable Video Data Link

N95-177	Development of Improved Methods for Removal of Conformal Coatings from Electronic Printed Circuit Boards
N95-178	Develop Customized Training Using Artificial Intelligence Methods
N95-179	Develop a Unified Architecture for a Real-Time Distributed, Electronic Warfare (EW) Simulation
N95-180	Develop a Real-Time, Wave Propagation Model for Heterogeneous Clutter Scenes.
N95-181	Surf Zone and Craft Landing Zone Obstacle Clearance.
N95-182	Develop Aluminum Stabilization of NbTi Superconducting Wire
N95-183	Design, Develop, and Demonstrate a Low Power Digital Signal Processing Multichip Module for Mine Warfare
N95-184	Develop a Miniature, Low Power Ocean Bottom Seismometer/Accelerometer (S/A)
N95-185	Develop a Miniature Magnetometer
N95-186	Develop and Produce a Large Screen Color LCD Projection System
N95-187	Develop a Miniature Diode Laser Velocity Sensor
N95-188	Develop Stealthy Materials for Moving Systems in the Sail of Submarines
N95-189	Development of Manufacturing and Assembly Methods for the Production of Acrylic/Fused Silica, Laminated, Composite, Heated Periscope Head Windows Using Electro-Conductive Coating Heating
N95-190	Develop and Produce New Elastomeric/Plastic Foam Materials for Shock Wave Attenuation
N95-191	Connection of Simulation Based Design (SBD) and Advanced Distributed Simulations (ADS) for Military System Development.
N95-192	Develop Mechanical and Environmental Test Procedures for Transmit/Receive (T/R) Modules Procedure
N95-193	Optimal Active Array Architectures for Communications Applications
N95-194	Develop a Channelized Direction Finder
N95-195	Development of an Automated Logistics Software to Implement Hardware Change Control and Parts Control from Problem/Failure Reports of the Cooperative Engagement Capability (CEC) Program.
N95-196	Develop a Lightweight Electronic Equipment Enclosure
N95-197	Chemistry of Self Propagating High Temperature Synthesis (SHS) Particle Clouds in Air
N95-198	Prompt Formation of Metallic Vapor Clouds
N95-199	Data Compression Techniques on Microwave Link
N95-200	Development of Rapid Prototyping of Application Specific Signal Processors (RASSP) Program Interface for the Cooperative Engagement Capability (CEC) Program
N95-201	Shared Aperture Concepts for Point-to-Point Communications

N95-202	Integrated Tester Software Diagnostics
N95-203	Improve Thermal Efficiency of Microwave Transmit/Receive Modules
N95-204	Develop Robust Nonlinear Control Technology
N95-205	Develop a Left/Right Passive Bearing Ambiguity Resolution Sensor (BARS) for Torpedo Defense
N95-206	Develop and Produce High Precision Sensors for Under-Ice Submarine Operations and Unmanned Undersea Vehicle (UUV) Missions
N95-207	Develop and Produce High Resolution Image Processing with a MidFrequency Active Sonar
N95-208	Develop and Produce a SSTD Launch Canister
N95-209	Develop New Towed Array Technology
N95-210	Develop and Demonstrate Active Sonar Target Motion Analysis
N95-211	Develop a Surface Ship Acoustic Countermeasure (CM)
N95-212	Develop Mission Adaptable Control Strategies for a Resilient Unmanned Undersea Vehicle (UUV) Control System
N95-213	Shipboard Production of Intravenous Fluids
N95-214	Portable Rapid Tests for Diagnosis of Campylobacter Enteritis and Shigella Dysentery in Operational Ship and/or Field Environments
N95-215	Optimization of Casualty Handling
N95-216	Articulated Instrumented Manikin
N95-217	Active Thermal Absorbing/Insulative Materials
N95-218	Application of Neural Networks for Pattern Recognition in Logistics Data
N95-219	Thermal Management for Strategic System Nosetips and Leading Edges
N95-220	High Definition Spatial Light Modulators for Displays Methods
N95-221	Software Automation for Distributed System Development
N95-222	Command-Level Drug Testing Strategy
N95-223	Adaptive Tutor for Conceptual Knowledge
N95-224	A Tool for Modeling Distributed Decision Making in Complex Environments
N95-225	Eliminating Fatigue Failures in the Navy Infrastructure
N95-226	Rapid Pipe Pile Cutoff Technology in Support of Amphibious Logistics Operations
N95-227	Portable and Light Surface Mapping/Volume Measurement Tool

DEPARTMENT OF THE NAVY SBIR 95.3 TOPIC DESCRIPTION

OFFICE OF NAVAL RESEARCH

N95-068 TITLE: User-interfaces for Rule-Based Formal-Methods Environments

OBJECTIVE: Develop enabling technology that will enhance the ability of software engineers to apply formal-methods techniques to safety-critical applications.

DESCRIPTION: Formal methods offer great promise for the elimination of software errors in safety-critical systems. Before formal methods can be widely adopted in industry, they must be supported by tools readily acceptable to professional programmers. Of particular importance are tools that couple the creation of formal specifications with automatic or semi-automatic tools (theorems and proof-checkers) for the verification of such specifications. Existing formal-methods tools are often hobbled by weak, obscure, amateurish, or non-standard user-interfaces. In addition, the supporting tools are not mature, nor are they integrated with commercial CAD/CASE tools. The long-range goal is to create a high-level, customizable, portable, common user-interface tailored to formal-methods applications. A near-term objective is to address the many straightforward applications realizable by a set of rules that take an input and a state to an output and a new state, and which are amendable to formal verification technologies. Often such designs have a practical tabular representable and are a useful intermediate step towards a target language code generation such as in Ada or C.

PHASE I: Develop a design for a software prototype of a "formal-methods interface" (FMI). This FMI must address and justify coordination management among back-end theorem provers, model-based simulation and the FMI. Important FMI features and capabilities should be described through "storyboard" illustrations.

PHASE II: Create a prototype FMI usable with several theorem-proving and proof-checking systems (e.g., PVS, HOL, Nth, Nuprl, and Coq), model-based systems (e.g., FDR), and simulation system for appropriate demonstration purposes with instantiations of the FMI for many of the candidate formal-methods systems.

PHASE III: Potential follow-on efforts are anticipated on government projects in software safety-critical systems and in particular on C^4I projects.

COMMERCIAL POTENTIAL: The development of safety-critical systems is carried out by both defense-related and non-defense-related companies such as aerospace applications, medical software, automotive control, and micro-processor chip design and testing. Improved tools for formal-methods techniques would have significant impact both in training and in production applications. Growing numbers of applications stand to benefit from the application of formal-methods techniques. Society is increasingly at risk because of the lack of their application as recently witnessed with the floating point arithmetic failure of the Intel Pentium microprocessor which did not verify the correctness of its design. Increased computing power and improvements in implementations of verification tools offer a real chance for these techniques to have significant impact. A formal-methods interface could help as a catalyst for quicker acceptance.

REFERENCES:

1. G. Cherry, Software Engineering with Ada in a New Key: Formalizing and Visualizing the Object Paradigm, "Proceedings of TRI-Ada '94", November 1994.
2. R. Constable, et al.; Implementing Mathematics with the Nuprl Proof Development System. Prentice-Hall, Englewood Cliffs, NJ, 1986.
3. J. Cuadrado; Teach formal methods. Byte, December 1994.
4. L. Thery, Y. Bertot, and G. Kahn; Real theorem provers deserve real user-interfaces. Proceedings of the Fifth ACM SIGSOFT Symposium on Software Development Environments, (Tyson's Corner, VA, Dec. 9-11, 1992), ACM SIGSOFT Software Engineering Notes 17, 5 (December 1992), pp. 120-129.
5. S. Owre, N. Shankar, and J. M. Rushby; The PVS Specification Language (Draft), Computer Science Laboratory, SRI International, Menlo Park, CA, March 1993.

N95-069 TITLE: Uncertain Data in Information Engineering

OBJECTIVE: To develop algebraic techniques for processing uncertain, imprecise, and conditional information with variable conditions in a way faithful to both logic and probability.

DESCRIPTION: Information engineering concerns the organization and management of large amounts of data on an "enterprise-wide" basis. Management information systems must handle information which might be uncertain, probabilistic, non-monotonic, temporal, default, propositional, or fuzzy. Often such information arises in real world situations (e.g., when only partial information is available, or information is hypothetical). Current language standards (e.g., SQL) do not fully address the range of possible information type interactions. This can lead to inconsistent results. For example, the use of null values in a DBMS may lead to query results different from a DBMS that uses default values for representing partial information. Another example involves material implication of classical logic. With the closed-world assumption material implication can be easily expressed as a propositional statement; however, in a context where both propositions and facts are uncertain, this identification may not be warranted. All information has context and conditions under which valid inferences are made. The lack of understanding of these conditions and rules of inference may lead to problems in the fusion of information.

PHASE I: Develop a mathematical basis for the fusion of different types of information as mentioned above; identify problems where current approaches may lead to inconsistencies, contradictions, or the absence of meaningful information; and develop approaches to identify and remove circularities, redundancies and inconsistencies in a knowledge base.

PHASE II: Develop a functional prototype that is operable with and extends a standard query language (e.g., SQL or KQML) that is based on the results of Phase I. Validate this prototype on realistic problems that have arise in C^4I systems.

PHASE III: Potential follow-on efforts include government projects in database, statistical databases, software safety-critical systems, and in particular on C^4I projects.

COMMERCIAL POTENTIAL: This technology applies to data bases, knowledge-bases, artificial intelligence, robotics, Bayesian analysis, computer languages, statistical contingency data analysis, and theoretical computer science. Current methods of managing and reasoning from uncertainty data are ad hoc. This effort seeks to raise the level of assurance in the quality and reliability of the answer to any query involving uncertain information. The commercialization potential results from a robust software product and for impacting query language standards.

REFERENCES:

1. Dubois, D. and Prade, H. (1991). "Conditioning, Non-monotonic Logic, and Non-standard Uncertainty Models", in: I.R. Goodman, M.M. Gupta, H.T. Nguyen and G.S. Rogers, eds., Conditional Logic in Expert Systems, (North-Holland, Amsterdam) 115-158. ADA241664

2. Goodman, I. R., Nguyen, H. T. and Walker, E. A. (1991A) Conditional Inference and Logic for Intelligent Systems: A Theory of Measure-Free Conditioning, North-Holland. ADA241568

3. Gunter, Carl, (1992) "Powerdomains, Conditional Event Algebras, and their Applications in the Semantics of Programming Languages", Final Technical Report, March 25, 1992, University of Pennsylvania Department of Computer and Information Science.

N95-070 TITLE: High Power Electronics

OBJECTIVE: Develop semiconductor power amplifiers capable of controlling 10 times the voltage and 40 times the power of present silicon devices.

DESCRIPTION: Innovative new approaches have shown that high bandgap (e.g., > 2 eV) semiconductors exhibiting significant improvements in thermal conductivity, dielectric strength, and charge carrier velocity may now be synthesized with purities approaching that in silicon. This capability will enable thrusts emphasizing (1) high power actuators and motor controllers capable of replacing hydraulic devices on ships and aircraft, (2) high power microwave/millimeter wave vacuum tube replacement amplifiers, and (3) efficient and versatile electric drive systems for ships and vehicles.

PHASE I: Demonstrate 10-fold improvement over silicon in breakdown strength of a small device.

PHASE II: Demonstrate 40-fold improvement (over silicon) in power output from an amplifier of equivalent dimensions.

PHASE III: Demonstrate a microwave power amplifier exhibiting 5 times the power output of a GaAs device of the same dimensions.

COMMERCIAL POTENTIAL: This will advance the state-of-the -art for all electric vehicles.

REFERENCES:

1. Matus, L. G., Powell, J. A., and Salupo, C. S.,"High Voltage 6H-SiC p-n Junction Diodes", Appl. Phys. Lett. 59, pp.1770-2 (1991).

2. B. J. Baliga, "New Materials beyond Silicon for Power Devices" in "Power Semiconductor Devices and Circuits", Ed. by A. Jaecklin, Plenum Press, New York, pp. 377-388, (1992).

N95-071 TITLE: Gallium Nitride (GaN) Based Blue-Green Emitters on Silicon-on-Insulator (SOI) Substrates

OBJECTIVE: Develop large area (8-inch diameter) Silicon Carbide (SiC) substrates made from SOI wafers, and blue-green light emitters fabricated using Gallium Nitride (GaN) and Indium Gallium Nitride (InGaN) on these (SiCOI) substrates--using Aluminum Nitride (AlN) buffer layers, and integrate the emitters with Si-based logic devices on the same wafers.

DESCRIPTION: A high quality compliant substrate called SiCOI contains low defect density, thin, cubic silicon carbide layer on SiO_2 on Si, and is made from a commercially available 8-inch or 5-inch diameter SOI substrate. SiCOI can be a platform for integration of wide bandgap semiconductors with Si-based logic. Blue light emitting diodes (LEDs) based on GaN can be fabricated on SiCOI at much lower cost than on sapphire or SiC substrates now in use for GaN-based devices.

PHASE I: Develop process for conversion of thin Si layer on top of SOI wafer to cubic SiC with low defect density, evaluate characteristics of SiC layers, and initiate growth of GaN-based structures on these SiCOI wafers.

PHASE II: Fabricate GaN-based LEDs on SiCOI wafers and optimize process for conversion of SOI to SiCOI.

PHASE III: Develop 5-inch and 8-inch SiCOI substrates for SiC-based electronics, transmitter for optical bus communication, (consisting of LED array on SiCOI chip with integrated LED driver circuits and DRAM buffer on the base Si wafer), and related chips to integrate LEDs with Si devices.

COMMERCIAL POTENTIAL: Integration of blue and green LEDs with Si logic for optical communication and display applications, and low cost SiC substrates for high temperature, high power devices.

REFERENCES:

1. Powell, A.R., Iyer, S.S., and LeGouses, F.K., "New Approaches to the Growth of Low Dislocation Relaxed SiGe Material," Appl. Phys. Lett. 64 (14), 4 April 1994.
2. S. Nakamura, T. Mukai, M. Seno, "High Power GaN P-N Junction Blue-Light Emitting Diodes," Jpn. J. Appl. Physics, 30, L198 (1991).

N95-072 TITLE: Optoelectronic Signal/Image Processing for C3I Applications

OBJECTIVE: Develop optoelectronic technology and/or signal processing modules that will support command, control, communications, and intelligence (C3I) systems; specifically, multi-function phased array antennas.

DESCRIPTION: Future systems will reduce the number of separate shipboard and airborne antennas by sharing adaptive phased array antennas, multifunction receiver modules, and common signal processing resources. Enabling technologies for this concept include wideband phase shifters, high dynamic range fiber optic links (140 dB/2 GHz), methods for adaptive multiple-beam steering, optical techniques for addressing and interconnecting large numbers of wideband target recognition modules, and robust methods of automatic target recognition (ATR). Fiber optic links with high spurious free dynamic range (>140 dB) are needed to achieve the required receive only signal distribution for the next generation surface combatant. Proposals which exploit the inherent parallelism of optical systems or the speed/bandwidth of photonic technology, including nonlinear optical phenomena, will be considered.

PHASE I: Investigation of proposed concept; identification of innovation and discussion of technical issues. If possible, given technical status and funding, conduct laboratory demonstration proving feasibility of concept or resolution of controversial issue.

PHASE II: Design of prototype; demonstration of concept with prototype system; discussion of all relevant performance scaling issues and production or manufacturing issues.

PHASE III: Develop Phase II prototype; demonstrate in naval system.

COMMERCIAL POTENTIAL: The wideband technology components and systems developed for this program have numerous private sector applications within the high-speed telecommunications, satellite communications, and digital multimedia distribution markets. In addition, relevant software products designed for efficient resource allocation and data fusion are equally applicable to industrial concerns.

N95-073 TITLE: Ultra-High Isolation Circulator/Duplexer for Surveillance and Communication

OBJECTIVE: The objective of this effort is to develop the most feasible approach to obtain more than 120 dB of isolation in a UHF (200 to 1850 MHz) M port circulator/duplexer. Other performance criteria include low insertion loss (3 dB) and 60 dBm peak power handling capability for transmit and receive applications.

DESCRIPTION: The Navy has constraints in its ability to add new antenna systems to its ships due to the proliferation of antennas currently adorning their topside real estate. One solution to this problem is to combine shipboard systems to utilize a single antenna aperture thereby reducing the number of antennas required and making space available for new ones. To do this Ultra-High Isolation Circulators/Duplexers, exceeding 120 dB, need to be available to achieve the required isolation between transmit and receive functions as well as between systems. This problem is currently referred to as Electromagnetic Interference (EMI) and our goal is to obtain Electromagnetic Compatibility (EMC) between collocated systems.

PHASE I: This part of the investigation will entail defining the problem and assessing the current state of isolator technology in Active (solid state), Passive (ferrite), and Emerging (cancellation) technologies that will lead to solutions. Further, an initial design and demonstration of the isolation properties of the successful approach, and a prototype design of a three port Ultra-High Isolation Circulator/Duplexer, should be addressed.

PHASE II: This part of the investigation will entail transitioning the successful isolation technology to an two-port isolator, a three port circulator, and an M port circulator which meet the program specifications and packaging requirements for both Military and Commercial applications.

PHASE III: The successful devices from Phase II will be transitioned into a Navy Advanced Technology Demonstration.

COMMERCIAL POTENTIAL: The commercial sector will make use of ultra-high isolation circulators in the automobile and communications industries. A specific example of an application would be to combine functions such as global positioning, personal (cellular) communications, and intelligent vehicle highway system functions into a single wideband aperture mounted on/in the roof of a vehicle. These systems will be coming to automobiles by the year 2000 and the need for this technology to be identified in order to obtain the required system performance.

REFERENCES:
1. Goto, "The Impact of Mobile Radio Communications", IEEE Antennas and Propagation Transactions, Vol. 34, pp. 22-29, April 1992., IEEE Microwave Theory and Techniques Transactions

N95-074 TITLE: Underwater Autonomous Power Generation

OBJECTIVE: The objective of this work is to develop a system to trickle charge batteries on the sea floor using mechanical energy available from the local environment.

DESCRIPTION: Future autonomous oceanographic sampling systems will use small autonomous underwater vehicles deployed for many months. The vehicles will recharge their batteries at docking stations on the ocean bottom that contain a cache of batteries. Mechanical, solar and/or thermal energy will be used to trickle charge the battery cache. The focus of this effort is a mechanical system for recharge that utilizes wave and current energy as available near-bottom. Two configurations are envisioned: shelf and deep ocean. The system should be compact, rugged and intelligently manage input mechanical energy types/levels and optimum cycling of state-of-the-art batteries (e.g., lead-acid, silver-zinc, lithium).

PHASE I: System design and evaluation of engineering/cost trade-offs including expected power output in representative ocean regimes and management of different battery types.

PHASE II: Fabrication, testing and evaluation of prototype systems deployed in the ocean (shelf and deep regimes) for at least one month.

PHASE III: Transition of the system to the autonomous oceanographic sampling networks for basic research, mine countermeasure and ordinance disposal missions.

COMMERCIAL POTENTIAL: Commercial applications include powering sensor systems for environmental monitoring and prediction, for satellite ground truth, for marine navigation, for fisheries management and for resource development. Common to these applications is the need for remote, undersea measurements with infrequent service intervals to be cost-effective. Local power generation will extend the service life of such systems and enable more data to be telemetered in real time through satellite and cellular phone links.

REFERENCES:
1. Curtin et al., 1993. Autonomous Oceanographic Sampling Networks. Oceanography, 6(3): 86-94.

N95-075 TITLE: Inertial Navigator on a Chip

OBJECTIVE: The objective of this work is to develop a low cost, low power inertial navigation system in a microprocessor form factor for use in small autonomous underwater vehicles.

DESCRIPTION: Future autonomous oceanographic sampling systems will use small autonomous underwater vehicles deployed for many months. Absolute geolocation, attitude and precise relative navigation are critical capabilities for such systems. A geo-located inertial navigator is sought using new micro-electro-mechanical technology. Sensors and signal processing hardware/software should be integrated within a single low power microprocessor-scale chip. In addition to power and cost, utility will be determined by the drift rate, which should be minimized, and the capability to detect the local geographic reference frame (magnetic north, local gravity). The network-class vehicles of interest have a speed range of 1 to 5 knots, and are stable in attitude to within a few degrees. Long intervals of submerged operation will limit access to the satellite-based global positioning system, which should not be relied on as a primary input.

PHASE I: System design and evaluation including sensitivity, drift rate, power consumption and geo-location accuracy.

PHASE II: Fabrication, testing and evaluation of a prototype system deployed on a network-class vehicle operating in the ocean for at least one month.

PHASE III: Transition to the Autonomous Oceanographic Sampling Network for basic research, mine countermeasure and ordinance disposal missions.

COMMERCIAL POTENTIAL: Commercial applications include environmental monitoring and prediction, satellite ground truth, marine salvage, and fisheries management. The many industries associated with these activities will benefit.

REFERENCES:
1. Curtin, et al., 1993. Autonomous Oceanographic Sampling Networks. Oceanography, 6(3): 86-94.

N95-076 TITLE: Data Management and Satellite Relay for Environmental Research Aircraft

OBJECTIVE: Development of a data management system and in-flight satellite telemetry capability for real-time data analysis and interactive in-flight aircraft operations.

DESCRIPTION: Innovative data management and satellite telemetry schemes are solicited to support environmental research. Over-the-horizon communications are required to fulfill long duration (24 hour) and long range measurement strategies. In addition, researchers must be able to monitor data collection for real-time decision making and flight operations. The system that is solicited here shall: a) coordinate data streams from various onboard sensors (possibly operated in different configurations), b) provide onboard storage of all data collected, and c) telemeter selected data, video, and all flight control commands via satellite communications to a ground station for real-time analysis and system operation. The command and control system shall use a currently available communication satellite (such as INMARSAT) that continuously provides at least 1200-baud data average transmission rates. Innovative data handling schemes will be required to collect, process, and transmit high data rates from a variety environmental sensors and flight control systems.

PHASE I: Describe a system concept complete with data management and telemetry capabilities.

PHASE II: Produce a viable prototype system and demonstrate it's ability to support in flight data management and telemetry of scientific data and flight control commands from an operating Cessna 337-type research aircraft.

PHASE III: Transition the technology to vendors and customers.

COMMERCIAL POTENTIAL: Data management and over the horizon communications for research aircraft can be used to support a variety of world meteorological, oceanographic, and commercial needs.

N95-077 TITLE: Nonlinear Signal Enhancement and Bandwidth Reduction of Image Data Using Computational Fluid Dynamics Techniques

OBJECTIVE: Develop and demonstrate feasibility of signal enhancement and bandwidth reduction, using nonlinear dynamical techniques, applicable to image data which will provide the capability of recovery from transmission errors and provide improved storage efficiency and increased data transmission rates.

DESCRIPTION: Image enhancement techniques based on various transform and statistical approaches are well developed, and their success is well known. Nonlinear techniques based on dynamical approaches are more recent in their development, but promise novel signal processing capabilities. It is envisioned that significant advances in error reduction and data transmission rate may be possible using these nonlinear techniques. The specific application required here is to detect partially obscured mines and barriers, minefields and barrier fields in general, in the surf zone and in shallow water.

PHASE I: Develop a signal processing technique for improving mine and minefield (and barrier and barrier field, and mixed) detection capabilities in the surf zone and shallow water using the indicated nonlinear signal enhancement techniques which will outperform or at least compete with existing techniques. Compare the technique against typical images and typical (even stressing) levels of background clutter and varied background textures.

PHASE II: Produce and demonstrate a finished software package of ready-to-use algorithms for mine and minefield (as well as barrier, barrier field, and mixed) detection, classification, and identification based on the developed nonlinear approaches which will run on a shipboard or airborne personal computer.

PHASE III: Bring the finished software package into production in a form that meets Navy needs for application to littoral warfare.

COMMERCIAL POTENTIAL: Software and related hardware developed would provide enhanced capabilities in medical imaging, satellite imagery, paramilitary reconnaissance, and industrial applications.

REFERENCES:
1. S. Eidelman, W. Grossmann, and A. Friedman, "Nonlinear Signal Processing Using Integration of Fluid Dynamics Equations," Proc., SPIE 1567, 439-450 (1991).

N95-078 TITLE: Four-dimensional (4-D) Oceanographic Instrumentation

OBJECTIVE: To develop innovative instrumentation to measure oceanographic and/or meteorologic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric and oceanographic variables (e.g., acoustical, optical, physical, biological, chemical, and geophysical) in 3-D space and time. The emphasis must be placed on (1) novel approaches and concepts for measuring multiple parameters coherently in 4-D, and (2) new methods of measuring turbulent fluxes, acoustic wavefields, or fluid motion of multi-phase mixtures (e.g., water/bubbles/sediments/biologics). Instruments can be individual towed/tethered sensors, elements in arrays, or suites of instruments on unmanned vehicles/platforms to cite a few examples. Low cost, reliable and possibly expendable sensors/components are particularly desirable. Full depth capability is desired in instrumentation planned for subsurface use. Particular capabilities are sought for bubble and spray population measurements, dynamic void fractions in water, small scale turbulent fluxes of heat mass & momentum, and near bottom sediment fluxes.

PHASE I: The Phase I effort should provide a description of exactly what will be measured and to what accuracies and coherence as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II: The Phase II effort would develop hardware and demonstrate feasibility via laboratory and/or field testing.

PHASE III: Phase III would transition the instruments to ocean science researchers, ocean monitoring systems and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments/technology can be used in commercial ocean monitoring systems.

N95-079 TITLE: Innovative Multimedia Man Machine Interface Concepts

OBJECTIVE: To develop interactive man machine interface concepts which will reduce undersea platform operator workload

and present an easily understood array of information to afford a clear and accurate picture of the tactical environment.

DESCRIPTION: A need exists for the development of an interactive man machine interface capable of presenting data from multiple sources and of varying types to an operator in a clear, unambiguous manner, while minimizing the workload required of the operator. This man machine interface must be able to present to an operator all information about a tactical situation pertinent to the type of task being performed, e.g., acoustic warfare, drug interdiction, air traffic control, and allow the operator to interrogate the data and vary the level of data presented as required by the situation. This man machine interface must present data in real time highlighting important features of the environment/situation in an easily recognizable manner.

PHASE I: Explore multimedia man machine interface concepts

PHASE II: Implement concepts in a prototype for demonstration with data fusion technology developments

PHASE III: Transition prototype to production systems

COMMERCIAL POTENTIAL: The display of data to operators becomes an increasingly more difficult task as the amount and types of data to be presented increases. This is true in a military application such as acoustic warfare as well as the tracking of targets and weather for the FAA, or the sorting of possible drug trafficking aircraft in a busy traffic corridor. As systems develop to higher levels of complexity, more data is available for exploitation. In order not to completely overwhelm the system operators, the man machine interface must be carefully designed to present the data in a user friendly and natural way. The use of multimedia technology may provide a better means to help an operator have a clear understanding of the situation in which he/she is working.

N95-080 TITLE: High Temperature Batteries for Underwater Vehicle Propulsion

OBJECTIVE: Demonstrate the performance capability of high temperature batteries to increase the range and speed of underwater systems.

DESCRIPTION: The silver oxide/zinc (AgO/Zn) battery is the Navy's workhorse power supply for driving a number of its underwater vehicles, like Swimmer Delivery Vehicles, Deep Submergence Rescue Vehicles, torpedoes and torpedo targets. For such use, AgO/Zn offers the highest energy density of any commercially available, high power rechargeable battery. However this energy density is still insufficient to power the run times needed by future vehicles especially at sea water temperatures. Under these conditions a high temperature battery has the potential to provide three to four times the gravimetric energy density. Naval vehicles require from 100 to 160 volts for 6, 10 and 20 hour periods, typically, and most applications require no more than 100 cycles. The space for the power supply is often limited to an 18- or 36-inch diameter.

PHASE I: Design a high temperature battery power supply for underwater vehicles. Evaluate energy and power densities (both gravimetric and volummetric) as a function of the energy content and physical size (including all ancillary components)of the high temperature battery. These should include all additions to the battery to assure safe operations in the vehicle, on the deployment platform, and in storage.

PHASE II: A specification will be provided for a specific application which will be representative of one or more of the sizings from Phase I. Bench top demonstration of the high temperature battery chemistry.

PHASE III: Transition for further development into the ONR High Energy Battery Task (RJ14Y41).

COMMERCIAL POTENTIAL: Electric vehicles for civilian use. Quiet electric vehicles for front line military use.

REFERENCES:

1. E.J. Cairns, The Electrochemical Society Interface, Winter 1992, p.39.
2. Anon., International Defense Review, September 1991, p.944.
3. Handbook of Batteries and Fuel Cells, D. Linden, ed., McGraw-Hill, New York, 1984. Table 26-6, pp. 26-9.

N95-081 TITLE: Nonlinear Dynamics of Crane Operation at Sea

OBJECTIVE: The goal of this research is to devise automated crane operating procedures based on the nonlinear dynamics of crane cable motions at sea to allow the safe transfer of cargo in Sea State 3 and above.

DESCRIPTION: The Navy uses crane ships to transfer cargo to smaller, lighter ships at sea when ports are not available for the heavier crane ship. The cargo is in standardized large containers. This transfer operation becomes dangerous when the

condition Sea State 3 is reached. This corresponds to 3 1/2 to 4 foot waves. Pendulation of the crane cable occurs as the load is lowered. In addition, the larger crane ship responds more to ocean swells, while the light ship is more effected by the local wave conditions. Highly skilled operators can still operate in Sea State 3, so safe operation is possible. Automated nonlinear dynamical control techniques have experimentally proved to be successful in controlling unstable behavior in lasers, circuits, actuators, and cardiac tissue. It is hoped these types of nonlinear controls can be applied to crane operation.

PHASE I: A realistic theoretical and numerical study of the operation of a three dimensional Navy style crane on a ship being driven by wave motions. This should illuminate all possible motions and instabilities in the crane-load dynamics as a function of Sea State. Automated control techniques will be developed and demonstrated. This can include developing a protocol of operation using available operator controls and data inputs, as well as, suggesting feasible design modifications and additional data input devices, eg motion sensors.

PHASE II: The theory of crane operation will be tested experimentally on a model with progressively higher sea states. This will include picking up a load and transferring it to a lighterage ship. Control will be applied in an automated manner to minimize cable oscillations.

PHASE III: Automated crane operation at sea will be tested on a Naval vessel.

COMMERCIAL POTENTIAL: Maritime fleets would benefit from safer crane operations at sea and increased efficiency by maintaining operations in higher Sea States.

N95-082 TITLE: High Efficiency Organic Light Emitting Diodes

OBJECTIVE: The simple fabrication of high efficiency (>4%), organic light emitting diodes using conventional, economical, processable polymers and simple room temperature processing.

DESCRIPTION: Overcome difficulties with conventional polymer light emitting diodes, which include (1) mismatch between the work-functions of the anode and the cathode materials and, respectively, the π and π^* orbitals of the electroluminescent polymer that result in a significant increases in operating voltage of the devices, (2) low mobility of injected charge carriers in undoped conjugated polymers (10^{-5} to 10^{-2} $cm^2/V.s$), (3) space charge effects near the electrodes limiting the carrier concentrations, (4) combination of low carrier mobility and low carrier concentration resulting in weak current (low brightness). (3) unbalanced densities of injected holes and electrons because at the two polymer/metal interfaces and resultant dependence of recombination rate on population of minority carriers (excess majority carriers simply reduce device efficiency).

PHASE I: Develop innovative solutions using alternative device architectures to overcome the above difficulties and exploit the phenomenon of polymer electroluminescence. Develop a novel approach to the injection of charge carriers into a conjugated polymer.

PHASE II: Reduce phase I effort to engineering practice.

PHASE III: Scale up synthesis/fabrication/processing to pre-production level; fabricate devices for air/fleet evaluation such as advanced information displays for Naval aircraft and vessels.

COMMERCIAL POTENTIAL: Displays for watch dial illumination, illuminated toys, and illuminated novelties.

N95-083 TITLE: Two-Dimensional Ultrasonic Imaging Array Transducer

OBJECTIVE: Devise materials processing methods to make a pulse-echo ultrasonic imaging transducer having the form of a two-dimensional array for forming three-dimensional images.

DESCRIPTION: Currently, ultrasonic images are made by sending an acoustic probe pulse and detecting returning echoes with a single element transducer or a line array of transducer elements; two-dimensional images are made by either mechanically or electrically scanning the acoustic beam in a plane. In order to speedily image a three-dimensional volume, two-dimensional arrays of transducer elements are needed. Fabricating the large number of very small transducer elements and providing the necessary electrical connections to each element presents demanding material synthesis and processing challenges, especially in obtaining a transducer material with high electro-mechanical conversion efficiency, in tailoring each element's electrical impedance to interface it efficiently to the transmit/receive electronics, and in matching the array acoustically to the imaging medium without introducing interelement crosstalk. This topic focuses on solving the materials issues in fabricating the two-dimensional transducer array rather than acoustics or electronics issues which are also needed for three-dimensional imaging.

PHASE I: Demonstrate materials fabrication methods for a two-dimensional array of ultrasonic transducer elements

with electrical interconnections to all elements. Determine acoustic and electric properties of candidate structures.

PHASE II: Devise materials processing methods to fabricate two-dimensional ultrasonic transducer arrays complete with acoustic backing and matching layers and electrical connections. Fabricate a prototype transducer array with high element sensitivity, high interelement isolation, and appropriate electric and acoustic impedance. Form three-dimensional acoustic images using the array.

PHASE III: Construct the transmit/receive and image display electronics to form three-dimensional volumetric ultrasonic images in real-time.

COMMERCIAL POTENTIAL: Key component of pulse-echo ultrasonic imaging systems for Navy undersea mine classification, non-destructive material evaluation, and medical diagnostic imaging.

REFERENCES:

1. R. L. Goldberg and S. W. Smith, "Multilayer 2D Array Transducers with Integrated Circuit Transmitters and Receivers: A Feasibility Study," Proceedings of the 1994 IEEE Ultrasonics Symposium.

N95-084 TITLE: Innovative Repair/Maintenance Materials for Navy Piers and Wharves

OBJECTIVE: Develop novel materials and processes applicable to Navy shore infrastructure for rapid repair and maintenance of concrete structures.

DESCRIPTION: Navy piers, wharves, and other waterfront structures must withstand regular usage with a minimum of maintenance and scheduled repair in an intrinsically aggressive marine environment. In addition, these structures must constantly stand ready for very heavy surge usage during critical times with little potential for extensive repairs either before or during surge periods. Innovative scientific, technological, or both approaches are needed to support the development of alternative cementitious (hydraulic) systems, repair materials and processes to maintain the integrity of concrete structures or return the structure to its design strength, and novel nondestructive inspection/evaluation procedures specifically designed to evaluate the integrity of large marine concrete structures.

PHASE I: During Phase I the contractor will be expected to survey current repair and maintenance techniques and contrast them with proposed replacement materials, processes, inspection techniques for naval shore concrete structures. Pilot demonstrations of minor repairs of cracking or surface spallation would be desirable.

PHASE II: Phase II should concentrate on the development of an integrated approach to pier and wharf maintenance and repair including inspection and repair materials and processes. Concepts for the accelerated screening of repair and maintenance concepts would be very desirable attributes of a Phase II effort. The compatibility of techniques to modern lightweight concretes would be a further advantage to any materials developed during Phases I or II.

PHASE III: Phase III would be expected to follow a successful Phase II with the contractor participating in the establishment of standard procedures that would be applicable to naval structures and in the supply of materials and processes and expertise to further development and application.

COMMERCIAL POTENTIAL: Although Navy shore structures have unique requirements with respect to surge usage coupled with often lower general usage and requirements for structural flexibility in usage, the structures themselves are virtually identical to commercial piers, wharves, and other waterfront structures. Repair materials and inspection techniques developed for Navy structures will be capable of direct application in commercial structures.

N95-085 TITLE: Explosions of Particle Clouds Comprised of Reactive High Temperature Materials in Air

OBJECTIVE: Develop methodology to disperse and ignite clouds of self-sustaining reactive materials using SHS (self propagating high temperature synthesis) technology, in order to achieve superior fuel/air explosive capability.

DESCRIPTION: It is essential to develop the methodology to ensure ignition and self propagation of solid fuels in dispersed fuel/air reactions. These systems normally have a tendency to quench because of the rapid volumetric expansion during dispersion. Consequently, the use of intermetallic/ceramic reactions such as SHS technology is needed in order to ensure that complete combustion and maximum performance can be achieved.

PHASE I: Develop an understanding of the conditions required for ignition and propagation of the SHS and subsequent fuel/air reactions. Demonstrate the capability to inject and form SHS particle clouds in air and to measure the

explosion blast pressure.

PHASE II: Develop and demonstrate the capability to disperse and ignite clouds of reactive SHS fuel particles such that complete fuel/air combustion is achieved. Conduct fuel/air test demonstrations and measure performance (blast pressure). Optimize experimental conditions such as dispersion conditions, choice of reactive materials, particle size, morphology, and porosity of system to maximize performance characteristics.

PHASE III: Transition technology into specific weapons programs for military application, and explosions/fire safety programs for industrial application.

COMMERCIAL POTENTIAL: The technology developed under this effort can be used to develop an understanding of dust cloud explosions which are serious concerns in several industries, such as coal mines, flour mills, and metal powder factories. The U.S. Bureau of Mines, Pittsburgh Research Center Fires and Explosions Office has expressed interest in supporting Phase II awardees in the adaptation of the processes developed here, for Phase III work in industrial programs.

REFERENCES:
1. J. E. Gatia and V. Hiavacek, Ceramic Bulletin, Vol 69, No. 8, 1990

N95-086 TITLE: CFD Code for Surface Pressure Fluctuations

OBJECTIVE: Develop a computational fluid dynamics (CFD) code for the prediction of spatially correlated pressure fluctuations on the surface of a structure in an incompressible turbulent flow sufficient for determining the resulting structural vibrations.

DESCRIPTION: Structural vibrations due to spatially correlated pressure fluctuations on a structure in a turbulent flow lead to unwanted acoustic emission to the interior or exterior fields. Prediction of these fluctuations is necessary for development of appropriate noise reduction techniques and/or control of the fluctuations themselves. Within the code adequate temporal and spatial resolution of the pressure fluctuations is required for the spatial correlations.

PHASE I: Develop a basic code to capture the essential features of the pressure fluctuations, including spatial correlations, for a turbulent flow over a simple geometry (eg., flat plate). Demonstrate extendability to practical configurations and flow conditions.

PHASE II: Develop, test, and demonstrate an operational code for practical geometries and flows. The code should be compatible with one or more standard gridding techniques and produce wave-number/frequency pressure predictions on the surfaces.

PHASE III: Produce a code incorporating the Phase II features for practical flow configurations as occur on naval vessels, commercial aircraft, automotive vehicles, and other industrial flow applications.

COMMERCIAL POTENTIAL: The code would find ready application in a number of industries addressing a wide variety of flow noise problems on naval, aerospace, and automotive vehicles, and numerous other fluid flow applications.

REFERENCES:
1. ASME NCA-Vol. 11 (Book H00713), 1991

N95-087 TITLE: Improvements to Naval Ship Engines Through Water Addition

OBJECTIVE: Investigate and develop potential modifications to Naval diesel engine and gas turbine engine cycles by using water addition to improve performance and reduce exhaust emissions.

DESCRIPTION: Engines used to power Navy ships are typically modifications to hardware designed originally for aircraft or land transportation applications. One modification that has not been exploited in the ship environment is the opportunity to introduce considerable amounts of clean water into the engine cycle. Recent advances in the production of fresh water from salt and brackish waters have now made it possible to consider water addition to engine cycles at rates equal to or greater than the fuel flow. It is known that if significant amounts of water are available, new thermodynamic cycles can be constructed so as to improve efficiency, raise power density, and/or reduce exhaust emissions. All of these characteristics have particular benefit to Naval applications where power plant and fuel occupy a large fraction of the platform. In addition, the detectability and survivability of a Naval ship are also quite dependent on the emissions and reliability of the power plant. It is therefore desired to examine how the thermodynamic, fluid control, and combustion chemistry effects of air breathing ship engines can

be re-optimized through the introduction of water to various locations of existing or appropriately modified Naval engine configurations.

PHASE I: Identify modifications to thermodynamic cycles using water augmentation, and develop optimization procedures. Characterize the effects of water addition on compression, combustion, control systems, and exhaust emissions. Examine the behavior of water injection/sprays for various geometries, flow fields, and temperature conditions.

PHASE II: Select engine arrangements that demonstrate the benefits of water addition, and perform testing new components. Explore water production methods appropriate to the needs of the cycles, rates and purity needed. Prepare preliminary designs of water augmented power plants as configured for shipboard installation.

PHASE III: Assemble a prototype engine and demonstrate, in cooperation with an engine manufacturer, its performance. Submit final designs showing engine, water systems, exhaust, and shipboard modifications needed for both a retrofit and a new ship application.

COMMERCIAL POTENTIAL: Many engine types used on Naval ships are also used on commercial ships. While the Naval optimization is different, a large part of the new water addition technology will be transferable. By bringing the engine manufacturer into the development, it is expected that the commercial applications will be accelerated, especially for engines with demonstrated performance. In addition, this technology should show considerable promise for land based engines where water is available, for example in power plants. The commercial potential seems highest in the areas of reduced pollution from exhaust gases and increased power density.

N95-088 TITLE: Actuators and Sensors Placement for Active Control

OBJECTIVE: Develop and demonstrate techniques and devices for optimal placement of actuators and sensors for active noise and vibration control.

DESCRIPTION: Active control of noise and vibration has received a great deal of attention and achieved a certain level of practicality. However, active control methods have some limitations and drawbacks that additional research and development efforts are needed for further implementations. These efforts include optimal placement for sensors and actuators, effective control strategy, and affordable control system components. For active control of sound radiation from structures, it is more effective to use structural sensing technique at the nearfield to estimate the far-field acoustic pressure. Collocated sensor/actuator control technique is stable, robust, and economical if the sensors and actuators are integrated properly. To be effective, control algorithms must be model-independent and do not require excessive computing. Most important, current control strategy needs to be extended to off-resonant, and broadband vibration and acoustic control.

PHASE I: Concept formulation: develop concepts and techniques for optimal placement of sensors and actuators for active control of noise and vibration on structures. Select applications and develop devices for test and evaluation.

PHASE II: Design, fabricate, test and evaluate devices to demonstrate the capabilities of optimal placement techniques. Demonstrations are conducted on practical systems commonly found in both military and commercial applications.

PHASE III: Transition methodology, technology, and devices to practical and engineering problems in both defense and commercial industries.

COMMERCIAL POTENTIAL: This technology would have direct applications to control noise and vibration on vibrating structures, such as aircraft structure, machinery, ground transportation vehicles, and home appliances.

REFERENCES:

1. Burdisso, R. A. and Fuller, C. R., Theory of Feedforward Controlled Systems Eigenproperties, Journal of Acoustical Society of America, 1990.

2. Dosch, J. J., Inman, D. J., and Garcia, E., A Self-sensing Actuator for Collocated Control," Journal of Intelligent Materials and Structures, January 1992.

3. Hagood, N. W. and Anderson, E. H., Simultaneous Sensing and Actuation using Piezoelectric Materials," SPIE Conference on Active and Adaptive Optical Components, July 1991.

4. Liang, C., Sun, F. P., and Rogers, C. A., An Investigation of the Energy Consumption and Conversion of Piezoelectric Actuators Driving Active Structures, Proceedings of the Second International Conference on Intelligent Materials, June 1994.

N95-089 TITLE : Simulation of Fracture in Fluid Structural Interaction

OBJECTIVE: Develop a dynamic fracture simulation capability for design and analysis of hull structures for dynamic events such as underwater explosion, ship grounding, and fatique.

DESCRIPTION: Several structural dynamics software programs are now used by the industry in crashworthiness analyses and other severe impact applications. In addition hydro codes have been developed for the simulation of shock and underwater explosions. None of these codes is capable of simulating the fracture process in large submerged structures, because they rely on finite element or finite difference which use structured meshes. Finite element methods are quite limited in their capabilities to simulate fracture, because cracks can generally only be modeled along the directions of the element edges. Therefore, modeling of arbitrary crack growth by finite elements requires continuous remeshing. The major breakthrough has been the development of the Element-Free Galerkin (EFG) computational method that is able to simulate fracture very accurately. This method is often called a meshless or gridless method, as the method requires only nodes. The interpolants which are used for the unknowns are moving least-square interpolants. In the EFG method, arbitrary cracks can move through the solid, and the problem of interest is modeled by a set of nodes and a Computer Aided Design-like model for the outside and inside surfaces of the structure, including any cracks which are modeled. The analyst does not have to know where cracks are emanating from and which direction they are propagating. Crack initiation and propagation criteria are provided by the user; the program then implants nodes and moves nodes in the direction of the crack with no elements or connectivity to be tracked.

PHASE I: Develop computer code capability base on Element-Free Galerkin. Perform the analysis of dynamic loading on a plate and compare its fracture. Demonstrate the coupling with existing hydrodynamic software for canonical geometries of submerged shells. Demonstrate strategy for parallel processing.

PHASE II : Couple code with existing hydrodynamic code for fluid simulation. Develop, test, and demonstrate the simulation capability for general geometries. Implement parallel processing for efficient computation.

PHASE III: Develop a general code with user documentation

COMMERCIAL POTENTIAL: Applications to: car and aircraft crashworthiness analysis, oil tanker grounding (design, litigation etc.), off-shore oil rig safety, power and gas industry safety and environmental impact studies.

REFERENCES:

1. T. Belytschko, "Element Free Galerkin Method," Keynote Address, Society of Engineering Science, 31st Annual Tech. Meeting 10-12, 1994.
2. B. Nayroles, G. Touzot and P. Villon, "Generalizing the Finite Element Method: Diffuse Approximation and Diffuse Elements," Computational Mechanics, 10, pp. 307-318, 1992.
3. T. Belytscko, Y. Y. Lu, and L. Gu, "Element Free Galerkin Methods," Int. Jnl. for Numerical Methods in Engineering, 37, pp. 229-256, 1994.

N95-090 TITLE: Parametric Analysis of Naval Ship Systems

OBJECTIVE: The objective of this effort is to develop a set of advanced design algorithms and implement them in the form of a software package which will allow a user to perform parametric analysis of shipboard systems (PASS). Specifically, PASS will rely heavily on first principles analytical models of all significant aspects of shipboard systems. The impact of parametric changes of a given system will be represented by the change to the system itself as well as its interaction with other systems. As a result, PASS will enable ship designers and systems engineers alike to assess the effects of changes in size, weight, and performance of a multitude of fundamental parameters defining operational systems and ship performance.

DESCRIPTION: PASS will enable navy ship designers to parametrically evaluate changes in systems and operational requirements on overall system performance. The basic core of PASS will have the capability of defining all significant subsystems of a ship, based on first-principles algorithms, to a level of detail sufficient to verify the feasibility of the ship with a proper balance of weights, volume and power. Additionally, the PASS user interface will allow a user friendly implementation of the models, while allowing the user to define the ship design to a useful level of detail. The advanced version of PASS will enable ship designers to assess overall shipboard improvements in survivability, covertness, and operational efficiency with the option to specify the platform.

PHASE I: Define all relevant systems (i.e., structure, propulsion, power plant, electrical, communications, weapons, etc.) and platform characteristics (i.e., size, displacement, volume, required complement, etc.), and compile these definitions into an analytical model.

PHASE II: This part of the development of PASS will involve enhancing the scope and accuracy of the first principles algorithms and verifying them by performing a detailed analysis on a representative test ship such as a modern guided missile destroyer. Also, a cost analysis modeling feature will be added to PASS. Most of the effort in Phase II will be focused on assessing and improving the models of shipboard systems and costs. This version of PASS will allow ship designers to quickly and accurately determine the payoff of parametric changes in system performance for a current or future ship design.

PHASE III: The refined version of PASS from Phase II shall further be developed to encompass the description of parameters related to ship survivability, covertness and operational efficiency. As in Phase II, essential improvements to existing models will be carried out, as well as the addition of new models as required to describe new shipboard systems as well as emerging technologies as they develop. In addition, PASS will become SURPASS and will incorporate sockets to CAD, NE, and IR packages which will allow optional implementation of platform specific analysis.

COMMERCIAL POTENTIAL: The commercial sector will make use of PASS in the design of both marine and terrestrial vehicles. The technology developed will be particularly useful to leverage small engineering firms into the automobile, bus, and marine vessel design and development sectors. Specifically, PASS will aid in the design of advanced fuel efficient vehicles and will eventually enable modeling of futuristic capabilities such as Intelligent Vehicle Highway System functions in particular.

N95-091 TITLE: Near-Infrared Fluorophores for Advanced Array Biosensors

OBJECTIVE: Produce new fluorophores suitable for biosensor signal transduction with excitation wavelengths greater than 665 nm and having electrophilic functionalities for covalent attachment to proteins and nucleic acids.

DESCRIPTION: In order to better exploit fiber optic biosensing based on fluorescence detection (via intensity, ratioed intensity or lifetime), reactive near-infrared fluorophores are required (to match diode laser sources and optical fiber transmittance). These fluorophores should contain electrophilic substituents (maleimide, N-hydroxy succinimidyl ester, isothiocyanate, haloacetyl or imidoester) for easy covalent attachment to protein and nucleic acid nucleophiles. They should be good fluorophores (quantum yield >20%, extinction coefficient >100,000 M^{-1} cm^{-1} in last absorption band, reasonably photostable) and soluble in water at ~1 mg/ml near pH 7 (<5% co-solvent if necessary). Peak absorbance should be no lower than 665 nm with peak emission in the range 690-1000 nm. Desirable excitation wavelengths include 670, 690, 790 and 830 nm (750nm and 850-1000 nm are undesirable). A series of affordable fluorophores is anticipated, with emphasis on solvent-insensitive emission (although high solvent sensitivity is also of interest). Combinatorial synthetic approaches might be considered.

PHASE I: Demonstrate synthesis of representative fluorophore (lacking electrophilic functionality if necessary), measure fluorescence emission spectrum.

PHASE II: Design, synthesize and characterize a series of reactive fluorophores with the desired properties. In consultation with the sponsor, attach these to representative proteins and nucleic acids and evaluate

PHASE III: Optimize and scale-up synthesis of best candidates from Phase II and prepare for transition to commercial production.

COMMERCIAL POTENTIAL: Civilian applications of near-infrared fluorescence-based biosensors in Clinical Diagnostics, Medical Imaging (both integrated into fiber optic networks eventually), Environmental Monitoring, Workplace Monitoring, Process Control and Applied Science are likely to be important.

REFERENCES:
1. Red and Near-Infrared Fluorometry by Richard B. Thompson (in Topics in Fluorescence Spectroscopy, Volume 4: Probe Design and Chemical Sensing, edited by J. R. Lakowicz, pp 151-181, Plenum Press, New York, 1994).

N95-092 TITLE: A Rapid In Vitro Diagnostic Kit to Detect and Identify Interferon-alpha in Patient Fluid Samples

OBJECTIVE: To develop solid-phase membrane technology (utilizing immunology/nucleic acid probes) for a commercially available in vitro diagnostic (IVD) kit that will rapidly detect, identify and semi-quantify interferon-alpha in patient fluid samples. This technology will assist the health care provider in distinguishing acute viral infections from acute bacterial infections and reduce the use of inappropriate drugs for the treatment of afflicted naval personnel either in a deployed field environment or in out-patient clinics.

DESCRIPTION: The government has a need for a diagnostic kit for rapid identification of interferon-alpha in patient fluids.

Recently it has been recognized that interferon-alpha may represent a clinically useful marker for acute viral infections. However, no clinically useful assay for interferon-alpha exists, although the peptide sequences of several of the interferon-alpha subtypes associated with viral infections are known. Available information should allow the design of a probe specific for the consensus sequence of interferon-alpha subtypes that is suitable for use in a solid-phase membrane-based kit. The availability of such a kit should allow reliable detection of interferon-alpha subtypes associated with human viral infections without the use of special equipment.

PHASE I: Design/develop a specific probe suitable for a solid-phase membrane-based IVD kit that is reactive with human interferon-alpha subtypes commonly associated with acute viral infections in patient fluid samples.

PHASE II: Validate the sensitivity and specificity of the IVD kit with acute phase human serum/plasma samples or other body fluids from confirmed viral and bacterial infections.

PHASE III: Evaluate the IVD kit under field-deployed conditions and submit for Food and Drug Administration approval per regulatory requirements for IVD kits.

COMMERCIAL POTENTIAL: It is widely recognized by clinicians that acute viral infections are indistinguishable from acute bacterial infections on clinical grounds, and the current practice is to prescribe antibiotics in the event that the infection is of bacterial origin. Being able to rapidly distinguish between viral and bacterial infections with clinical specimens will reduce this inappropriate use of antibacterial drugs in patients experiencing flu-like symptoms. A kit with this capability will both reduce costs of health care delivery and reduce the unnecessary build-up of drug resistant bacteria in human populations. The kit technology to be developed under this topic is directly applicable to manufacture of other IVD kits for clinical diagnosis.

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2. De Boissieu, D. et al. Viral infection in the neonatal period: diagnostic difficulties, the role of interferon alpha levels. Pediatrie (Bucur) 46:677-684, 1991.

N95-093 TITLE: Biofilters for Reduction of Gaseous Emissions

OBJECTIVE: Develop biofilters suitable for removal of volatile organic carbon (VOC) or volatile sulfur-containing compounds.

DESCRIPTION: Emissions of VOC or sulfur may create health hazards or cause noxious odors, and some emissions are regulated under the Clean Air Act. Sources of VOC and sulfur on shipboard include holding tanks for sewage, oily bilge and hazardous solvents. VOC emissions result from manufacturing, maintenance and disposal operations at DOD bases. Biofiltration devices can be engineered to provide efficient and cost-effective approaches to reducing emissions both on ship and shore. VOC and toxic sulfur emissions can be effectively removed using biologically based filtration systems such as biofilters, biological trickling filters and bioscrubbers.

PHASE I: Screen microorganisms for gaseous waste transformation; design physical-chemical support system for biofiltration.

PHASE II: Develop lab-scale biofiltration model to confirm transformation of emissions to benign products. Engineer scale-up to working model, and evaluate use in ship and shore applications.

PHASE III: Identify dual-use applications of biofilters for commercialization. Applications will include emission reduction on shipboard and at military bases, as well as reduction of industrial emissions in a variety of manufacturing processes.

COMMERCIAL POTENTIAL: Compliance with the Clean Air Act of 1990 will require innovative and cost-effective technologies. Markets for biofiltration technology are currently estimated to be in excess of $1 billion.

N95-094 TITLE: Haptic Interface Technology for Telerobotics and Virtual Reality

OBJECTIVE: Exploit and implement recent developments in the science of haptic sensing and sensor-driven control in humans and robots to advance the technology of haptic interfaces for telerobotic and virtual reality systems.

DESCRIPTION: There are a number of recent developments in the science of haptic sensing (touch and kinesthesis) and sensor-driven control in humans and robots that can inform the design of haptic interfaces for telerobotic and virtual reality systems in applications that require perception of features such as object shape, compliance, impact, contact, sliding, slipping,

and kinematic constraint. These developments include microsensors, haptic display devices, and display algorithms for encoding the feel and movement of real or virtual objects during manipulation or exploration. They also include advances in our understanding of the nature of haptic feedback needed to create a realistic haptic experience. The objective of this SBIR is to implement these promising scientific developments.

PHASE I: Carry out feasibility study for incorporation of advanced haptic sensors, display devices and haptic display algorithms into haptic interfaces for specific telerobotic or virtual reality systems. Provide demonstration of the feasibility.

PHASE II: Implement haptic interface technology in prototype hardware or software products. Demonstrate interface for application such as remote robotic manipulation, remote surgery, virtual environments for training.

PHASE III: Develop for commercialization haptic interface technology for telerobotic or virtual reality displays prototyped in PHASE II.

COMMERCIAL POTENTIAL: Haptic interfaces have a commercial potential in a wide variety of domains. Some of these are telerobotic manipulators for hazardous waste removal, nuclear plant maintenance and repair, oceanographic sampling, remote surgery; for virtual reality applications in the entertainment industry, in medical training, training in the aerospace industry; for computer interfaces.

N95-095 TITLE: Man-Machine Interface to Integrated Mechanical Diagnostics Systems

OBJECTIVE: To provide a realtime view of mechanical system health in high stress operational and combat environments.

DESCRIPTION: As we transition our aging fleet into the 21st century, concerns for safety and affordability are in the forefront. Ships, aircraft, land combat vehicles and submarines will be operational well-past their planned service lives thereby introducing a new set of challenges for fleet operators and maintainers. Accordingly, both the Safety and Logistics Round Tables identified the transition to "Condition Based Maintenance" and the maturing of mechanical diagnostics technologies as their number one priority. Mechanical diagnostics technologies emerging from the Navy S&T community will allow onboard, realtime processing of data to accurately determine machinery health. These technologies will be available commercially in three to five years. Although information vital to safety and weapons system readiness will be generated by onboard processors, present man-machine interface technologies are not capable of providing usable information onboard, in realtime. To harness the enormous power of integrated mechanical diagnostics systems, new approaches to man machine interface need to be explored. U.S. Navy forward deployed and Marine Corps expeditionary force operations will depend on onboard processing to safely support the doctrine of Operational Maneuver from the Sea.

PHASE I: Contractor will develop a (COTS) helmet mounded display demonstrator capable of displaying video imagery, color graphics and symbology. Video displays must be upgradable to HDTV-standards as those technologies mature. Video in Phase I will be used for mission scenario demonstration purposes. Also in Phase I, the video capability will be used to demonstrate an embedded training capability and an electronic tech manual for field maintenance personnel. Contractor will coordinate with ONR/NAWC (TSD) to incorporate actual mission video, audio and diagnostics graphics and symbology to produce a proof of concept demonstration centered on an actual combat mission scenario for a Marine Corps H-46 (medium lift) helicopter. Contractor will demonstrate one example of a video electronic tech-manual on the HMD for (off-board) use by H-46 maintenance technicians and one example of how embedded training could be incorporated in the MMI-system.

PHASE II: H-46 Flight demonstration. Begin avionics systems integration (with diagnostics system provider) for interface to a government specified integrated mechanical diagnostics system. The flight system will be capable of fusing data from (at least) two separate diagnostics subsystems and display this information in realtime. Contractor will coordinate with NAWC (TSD) and NAVAIR to gain appropriate hardware and software certifications and flight clearances. Contractor will deliver a flight-ready MMI system within one year of the beginning of Phase II. The flight system will also incorporate limited embedded training and video electronic tech-manual capabilities for off-board use by H-46 maintenance technicians using the helmet mounted display while on aircraft main or auxiliary power.

PHASE III: Transitions of MMI-technologies include the entire Navy and Marine Corps helicopter fleet of approximately 1200 aircraft. An immediate transition opportunity may be the H-46 program where the Program Manager has voiced a desire for integrated diagnostics systems as part of a Service Life Extension Program (SLEP) for the H-46. Another immediate opportunity is the U.S. Army CH-47 Program that is now planning integrated diagnostics for that aircraft in a modernization program. The British MoD is also very interested in these technologies. No investment in onboard, realtime MMI is taking place in Europe. We anticipate that the contractor would team with the diagnostics system provider to incorporate MMI technologies as an integral part of a realtime, onboard integrated mechanical diagnostics system.

COMMERCIAL POTENTIAL: There is a vast commercial market for MMI technologies worldwide. New technologies are increasing the power of mechanical diagnostics systems while dramatically lowering the cost. As such, the commercial customer base becomes (nearly) open-ended. Whether helmet mounted, goggle mounted or flat panel displays, the new technologies emerging from this SBIR will be tremendously valuable to the performer. In the emerging market for the next generation of realtime mechanical diagnostics systems, MMI will be a multi-billion dollar industry. Customers: commercial autos, trucking, machine tool industry, railroads, oil/gas industry, commercial aviation (helicopter/fixed wing), auto/boat racing, nuclear power industry, commercial shipping, and machinery-intensive heavy industry

REFERENCES:
1. Boff, K. R., Kaufman, L. and Thomas, J. P. (1986) Handbook of perception and human performance: Vol. 2, John Wiley & Sons: N.Y.

N95-096 TITLE: A Communication System for Analog and Digital Neural VLSI Microchips and Boards

OBJECTIVE: To develop a scalable communication system for neural event messages communicating between analog and digital neuromorphic VLSI chips and boards.

DESCRIPTION: The NAVY is developing analog VLSI sensors and pattern recognition systems in the acoustic and visual domains based upon neural network technology. Many applications will require the integration of multiple chips into tightly interacting subsystems where neural messages must travel from one chip to another or from one circuit board to another with proper accounting for message delays. Since analog neurons integrate signals in time, the communication system must not introduce latencies or variabilities that interfere with the neural integration mechanism. The goal of this SBIR is to develop a system that can 1) represent neural events taking place at a variety of sparse locations, 2) transport and route the event messages with adequate time representation, and 3) scale gracefully to very large multichip and multiboard systems using modular circuit board techniques with attention to size and power. Examples of this type of communication are the address-event, event-list and similar schemes proposed for action potential oriented neuromorphic analog VLSI. This SBIR work would allow efficient coupling and expansion of multiple address-event type pathways into a larger network of interacting neural network regions.

PHASE I: Develop communication protocols that generalize address-event and event-list schemes. Specify the hardware electrical and mechanical interface for a multiboard system. Demonstrate feasibility via a prototype of the system that has at least two neural network boards interacting over a backplane with central power distribution. Identify interface components best implemented in VLSI. Identify parameters that critically affect scalability.

PHASE II: Develop a complete demonstration system that integrates several neural network boards into a pattern recognition or control application while using both neuromorphic VLSI and classical digital neural network methods. Develop tools for system monitoring and performance measurement. Develop guidelines for deployment and for interfacing to existing NAVY electronic standards.

PHASE III: Productize the core components of the phase II demonstration hardware. Commercialize these items and seek industry standardization where merited. Develop and source custom VLSI support circuitry.

COMMERCIAL POTENTIAL: The core communication technology developed will conserve bandwidth and preserve timing relationships making it an enabling technology wherever neural networks are implemented in hardware that spans multiple chips or circuit boards.

REFERENCES:
1. Mead, C. Analog VLSI and Neural Systems, Addison Wesley, 1989.

N95-097 TITLE: Nonacoustic Sensors of Sliding Contact Mechanical Properties

OBJECTIVE: The detection of the state of mechanical "health" of a moving component, e.g., gear, bearing, or seal, is a major component in the growing field of condition based maintenance. Additional sensors of state variables, e.g., pressure, temperature, and chemical composition, must be embedded as integral components of moving parts and used as direct and early warning devices for mechanical failure. (We do not seek improvements or modifications of existing devices based on acoustic or acceleration sensing.)

DESCRIPTION: Many problems associated with ageing military vehicles, e.g., trucks, tanks and aircraft, in particular, have

to do with mechanical failure in critical elements. Rotor hub and transmission failures in certain helicopters, for example, have lead to a number of unfortunate fatal accidents. Past practice in maintenance is based on the cycle lifetime notion; vehicles and machinery are inspected on definite intervals and parts are replaced based on these inspections. The difficulty with this approach is that it does not work to detect many critical failures. In addition, the inspection process--requiring the dismantling of components--frequently introduces faults. The most tested approach makes use of acoustic sensors or accelerometers to detect adverse vibrations that arise and are associated with a failing component. The difficulty with condition-based maintenance has to do with (1) a general difficulty of knowing which mechanical elements are critical, and (2) the deconvolution of the acoustic signals received from various locations on the entire machine. Sliding solid contacts, such as gears and bearings, are difficult to investigate for the simple reason that it has proved difficult to insert appropriate probes into the interface. Some recent work has demonstrated that it is possible to insert thermocouples, pressure sensing devices, and even spectroscopic probes into the interface between two solid sliding contacts. Most current research obtains data on the conditions in the sliding contact--pressure, temperature, and chemical properties of lubricants.

PHASE I: Demonstrate that a new nonacoustic, nonaccelerometer in situ sensor can detect critical failure in a sliding contact sufficiently long before the actual failure occurs to be of use as a warning sensor. Such a demonstration can employ traditional scientific approaches, such as pin-on-disk measurements used in the study of friction and wear. However, the sensor must be an integral part of the sliding contact and cannot merely sense the state of a metal or other solid surface after emerging from contact.

PHASE II: Fabricate a working gear, bearing, or mechanical seal that incorporates the sensor or sensors and carry out tests to mechanical failure to demonstrate that the system works on actual components.

PHASE III: Initiate commercialization of the sensor in an appropriate system. The system can be a military machine (including weapon) or vehicle that is prone to critical mechanical failures.

COMMERCIAL POTENTIAL: There is a growing interest in condition based maintenance in the aerospace and automobile industries. In the civilian aerospace industry, for example, many of the problems that plague the military fleet also appear. Tight financial times have reduced the number of new airliners purchased and have greatly increased the necessary lifetime of the existing fleet. Retrofitting aircraft with critical element and critical failure sensors--as faults are detected--will greatly increase the lifetime of the aircraft, greatly increase the safety margin, and greatly reduce the overall operating costs. In the automobile industry, similar concerns for safety and economy of operation arise.

REFERENCES:
1. A. M. Williams, Y. Jiang and D. Ben-Amotz, chem. Phys. 180, 119-130 (1994): Chem. Phys., 183, 385 (1994)
2. P. D. Horak and U. J. Gibson, Appl. Phys. Lett., 65, 968 (1994)

N95-098 TITLE: Ductile-to-Brittle Transition in Molybdenum Disilicide ($MoSi_2$) and Related Materials

OBJECTIVE: Improve ductile-brittle-transition temperature (DBTT) theoretically (via modelling) and experimentally (via microalloying, for example) in order to provide materials for advanced fighter jet engine parts, such as blades, disks and vanes.

DESCRIPTION: $MoSi_2$ possesses almost all the attributes needed in a very high temperature structural material with use temperatures exceeding 1000^0C. The only drawback of $MoSi_2$ is its low ductility at low temperatures ($<500_0$C). At present, the DBTT of $MoSi_2$ is about 1000^0C, and it must be lowered to under 500^0C to exploit its full potential without sacrificing its high temperature creep and oxidation properties. In light of related efforts, efforts should focus on microalloying with elements to "ductilize" and toughen $MoSi_2$ intrinsically, permitting economical composition and convenient testing (as a monolithic material). (The addition of a second phase, such as SiC_p or SiC_w, is not to be considered.)

PHASE I: Theoretical analysis, perhaps by first principals and/or ternary and higher phase diagrams (verified by mechanical and metallurgical characterization).

PHASE II: Extension of approaches to produce larger samples of a family of promising "alloys" with and without particulate or whisker additions (e.g., SiC or Si_3N_4).

PHASE III: Develop manufacturing methods for jet engine or other propulsion system components with a prime contractor(s).

COMMERCIAL POTENTIAL: The market for a ductile and tough $MoSi_2$ is very large. Conventional $MoSi_2$ is presently used for heating elements in an oxidizing environment for $>1200^0$C service. Once the problem of toughness, or lack of it, is solved, markets for the material will undoubtedly open up for uses more mundane than that of high temperature heating elements.

N95-099 TITLE: Spatial Geometric Analysis Systems

OBJECTIVE: Develop enabling technology that will enhance the capability to apply constraint-based techniques to spatial geometric applications in mechanical engineering design.

DESCRIPTION: Constraint-based solvers offer an important approach to solving complex geometric problems that often arise in mechanical design. Unfortunately there is limited experience with this technology outside a few research groups. It is important to support development of such software tools that are robust and compatible with a few of the major commercial CAD systems and that provide functionality not currently available in existing commercial systems. Current tools are often limited range of applicability and robustness and are not well integrated with symbolic-numeric geometric data representations. The long-range goal is to create a high-level, customizable, portable, constraint-based spatial geometric solver tailored to CAD applications as arising in the areas of mechanical and assembly design. A near-term objective is to develop a spatial geometric constraint solver with the properties that it (1) does not require that constraints be satisfied in a fixed order, (2) solves a broad class of spatial problems, (3) is computationally efficient, (4) locates solutions when initial problem specification places the shape elements far from their final position, (5) provides for finding alternative solutions, and (6) is interoperable with several commercial CAD systems.

PHASE I: Develop required mathematical techniques and demonstrate a software prototype that demonstrates a important features of a geometric constraint solver. Develop a software design, a clear mathematical justification of its viability, and a software development plan to build a fully functional prototype realizing the above goals.

PHASE II: Develop and validate a fully functional prototype and that is interoperable with several commercial CAD systems. The validation must include realistic constraint problems arising from designs of equipment used by the Navy.

PHASE III: Potential follow-on efforts are expected in Naval ship design and production organizations, on civil engineering activities on government projects, and generally on the design of equipment used by the government.

COMMERCIAL POTENTIAL: A credible solution of the problem can be marketed to all major CAD vendors and many vendors dealing with robotics, major industry including aerospace, shipbuilding, and automotive.

REFERENCES:

1. D. Blackmore and M.C. Leu, Analysis of Swept Volume via Lie Groups and Differential Equations, International Journal of Robotics Research, Vol. 11, No. 6, 1992, pp. 516-537.
2. B. Bruderlin, Using geometric rewrite rules for solving geometric problems symbolically, Theoretical Computer Science, 116:291--303, 1993.
3. G. Crippen and T. Havel, Distance geometry and molecular conformation, John Wiley & Sons, 1988.
4. E. J. Haug, editor, Computer aided analysis and optimization of mechanical system dynamics, Springer-Verlag, 1984.
5. C. Hoffmann, On the semantics of generative geometry representations, In Proc. 19th ASME Design Automation Conference, pages 411-420, 1993.

N95-100 TITLE: Digital Assistant Technology

OBJECTIVE: Develop a prototype of a wearable conformable personal digital assistant for mobile and fixed-based work tasks.

DESCRIPTION: Personal digital assistant (PDA) technology extend conventional information infrastructure and technologies of local area networks (LANs) and computers into a flexible mobile setting. This evolution is evident from the emergence into the commercial marketplace of laptop computers, personal digital appointment notebook computers, and "anywhere" telephone numbers. Problems with PDAs arise from lack of a mobile digital infrastructure (e.g., differing from a conventional LAN), inadequate access in real-time to other computing resources (e.g. limited bandwidth obviated image file transfer), fragility and size of equipment, power management problems, and awkward human-computer interfaces for mobile work activities (e.g. typeboard/ mouse interface may be inappropriate for some tasks). The form and function of current PDAs can often be at odds with mobile tasks and the range of tasks to which they need to be applied. Designs must address general issues raised in the above description, issues of manufacturability and affordability of production, and be justified scientifically and technologically. The PDA environment should focus on applications to industrial/laboratory equipment maintenance and instructional classroom settings, involving several different human-computer interfaces and a wireless, adaptive, and mobile infrastructure for PDA operation.

PHASE I: Design an innovative form and function PDA and associated infrastructure from commercial off the shelf (COTS) technologies and from among emerging innovative technologies (e.g., micro-electro-mechanical systems, battery

technologies, voice recognition, solid-freeform fabrication, etc...).

PHASE II: Develop and validate a fully functional prototype. Demonstrate the prototype on a realistic Navy relevant training task for equipment monitoring and maintenance.

PHASE III: Potential follow-on efforts are expected in education and training, and in important equipment repair and maintenance tasks of government equipment.

DUAL-USE: PDAs will enable current fixed based activities to become mobile as needed. This will have a profound impact on education, and training. This concept can enable lesser-trained technicians to accomplish more complex tasks because they will have access to the information and knowledge of senior engineers where and when it is needed via PDAs.

COMMERCIAL POTENTIAL: A credible solution of the problem can be marketed by major OEM and other vendors dealing with software and hardware. In particular important commercialization potential is expected in major industries including aerospace, shipbuilding and repair, and automotive.

REFERENCES:

1. The current commercial PDAs include the Apple Newton or Sharp PDA. ONR and ARPA R&D investments in electronics, micro-electronic-mechanical systems, communications, and manufacturing technologies may provide capabilities to reduce size, weight, flexibility and power consumption and to increase computational capability and range of functionality. An FY95 ARPA initiative in "tactical information assistants" is complementary to this proposed topical area.

N95-101 TITLE: Solid Free-form Fabrication

OBJECTIVE: Advance the technology and manufacturing processes for solid free-form fabrication.

DESCRIPTION: Current solid free-form fabrication processes have proven their potential for many engineering and medical applications. Conceptualization models, fit check prototypes, manufacturability assessment artifacts, and prosthetics are examples of successful applications of these new technologies. The technological challenges include fabrication of larger parts, faster processing, increased part accuracy, and utilization of new materials that expand the range of functional parts fabricated using these processes. To meet these challenges will demand coordinated R&D efforts in many areas including (e.g.) materials, structures, rugged micro-electro-mechanical sensors and precision actuators, continuous in-situ process monitoring and control, computer aided processing, spray or deposition technology, and laser optics.

PHASE I: Identify and develop a technological advancement in an SFF processing. Justify the basis for the proposed advancement from considerations of scientific, technical, manufacturability, and affordability issues. Define project milestones and participant responsibilities, including partnership consortium descriptions if necessary.

PHASE II: Develop a functional prototype of the proposed technology in an operational SFF system. Demonstrate the capability of the system through the construction of a functionally gradient part of significant design and manufacturability complexity.

PHASE III: Transition to government activities involving design, modeling, rapid prototyping, production, and maintenance of equipment.

COMMERCIAL POTENTIAL: Several companies have recently been formed along the major competing SFF technologies. The technology offers the capability for the rapid production of complex custom parts and part models, which can significantly reduce the time and total cost for part development. In addition the creation of SFF service bureaus,accessible via electronic communications networks, offers potential capability to do remote, distributed design and manufacturing. As part size, accuracy, fabrication speed, and functional application increase and as the need for customized and specialty parts increases, demand for the technology will increase dramatically.

REFERENCES:

1. Proceedings of the Solid Freeform Fabrication Symposium, The University of Texas at Austin (1992, 1993, 1994).
2. Jacobs, P. F., Rapid Prototyping and Manufacturing, Society of Manufacturing Engineering Publications, Dearborn, MI, 1992.
3. Burns, M., Automated Fabrication: Improving Productivity in Manufacturing, PTR Prentice Hall, Englewood Cliffs, NJ, 1993.

MARINE CORPS

N95-102 TITLE: Lightweight Surveillance Radar Technology

OBJECTIVE: To provide technology, simulations, and prototype development for a miniaturized air/ground multi-mode surveillance radar.

DESCRIPTION: The end objective which this topic supports is to develop a miniature surveillance radar, including the antenna system, power supply system, and communications down link, small and light enough to fit into an Unmanned Aerial Vehicle (UAV). The UAV would be used to support airborne early warning (AEW), ground mapping, ground movement detection, and other missions through the use of a variety of in-flight, programmable scan and reporting modes. Data from the UAV-based radar system would be down-linked to a ground based command and control system. Advances in miniaturized solid state radar design, antenna technology, low power electronics, and UAV technology are all potential contributors to this effort. A currently produced UAV could be adapted to this mission, or a new UAV developed.

PHASE I: Perform preliminary design activities, modeling, and/or demonstrations for a miniaturized, multi-mode, radar system or for critical system components. Use Computer Aided Design and Modeling (CAD/CAM) as appropriate to provide preliminary estimates for radar and UAV platform performance.

PHASE II: Continue design activities for the radar system and/or for critical system components. Provide prototype demonstrations and/or detailed system level models. Detail the performance which could be achieved by a completed UAV-based radar system. Refine cost and schedule estimates.

COMMERCIAL POTENTIAL: The technology developed would have wide commercial application in areas involving radars for law enforcement, terrain mapping, environmental monitoring, and other areas. Variations of the completed UAV system could be used for traffic surveillance, drug interdiction, and radar-mapping.

N95-103 TITLE: Low Cost, High Waterspeed Obstacle Detection System

OBJECTIVE: To develop a low cost obstacle detection device that will be mounted on a surface vehicle travelling over water at high speed that is capable of detecting submerged objects.

DESCRIPTION: Current sonar and acoustic devices for detection of underwater and sub-surface obstacle are bulky, heavy, and expensive. Military versions are expensive and not easily mountable on small craft. Current commercial systems do not have adequate range or work at vehicle speeds over water at greater than 20 knots. This obstacle detection system shall include detection devices, processor, and operator display. This system shall be capable of discriminating objects as small as 20 pounds in mass and one cubic foot in volume at ranges between 100 and 400 meters from the craft. A 15 degree angle of inclusion shall be provided and a refresh rate of 2.5 cycles per second or greater is desired. The system that extends into or interfaces with the water shall be as small as possible so as not to provide unnecessary hydrodynamic drag, but must be able to operate close to the surface and be non-sensitive to spray and surface generated noise or disturbances. Operator feedback via a display or readout is required to be done in realtime mode.

PHASE I: The contractor shall perform trade-off and requirements analysis, followed by a detailed mechanical and electrical design for an obstacle detection system capable of being mounted on a flat bottom planing hull craft. Under this phase of the program, the contractor shall provide monthly progress reports, a commercial marketing plan, a final design report, and preliminary concept and layout drawings. The contractor shall host two meetings at his facility for government review (start of work and mid-review) and shall provide a final review to the Government at a Government site. An option to this phase which shall be included with the phase I proposal shall be preparation of detailed fabrication drawings and a breadboard demonstration (in the laboratory or in the field) of the highest risk technical aspect of the system.

PHASE II: The contractor fabricate and deliver one complete system of the obstacle detection device suitable for proof of concept demonstration on a planing hull craft. The contractor shall host status review meetings at his facility approximately every three months. Delivery of hardware, to take place after internal contractor testing, shall be 18 months after start of phase II effort. A fabrication report to include contractor test plans and test data and as-built drawings shall be delivered within 20 months after start of phase II efforts.

PHASE III: The contractor shall update the obstacle detection system based on contractor and government test results and shall deliver a ruggedized, second generation system suitable for vehicle testing. A development and fabrication report shall be delivered with the system within 9 months after start of phase III efforts.

COMMERCIAL POTENTIAL: A cost effective obstacle detection system for high speed craft will be of benefit to the pleasure boating and work boat industries that currently rely on sailor experience to avoid possible grounding of craft. High speed, small ferry operations that can not afford military grade sonar systems currently rely on observers to keep craft out of danger, but submerged obstacles are difficult to see in varied daytime/nighttime and different light conditions.

N95-104 TITLE: Portable Environmental Control System (PECS)

OBJECTIVE: To explore new endothermic (heat absorbing) materials for use as cooling media to Navy/Marine personnel in hot, humid environments and as a thermal heating source to personnel in cold environments; To design, develop, and fabricate PECS hardware for laboratory testing, field evaluation, and commercial marketing.

DESCRIPTION: Navy/Marine personnel are exposed to extreme hot and cold environments while performing their duties. Presently, the military inventory must stock separate gear for each condition. Endothermic materials research will be applied to the problem of climate control for military personnel. A single lightweight garment material is desired, working as both a radiating material in hot weather and an insulating material in cold weather.

PHASE I: The contractor shall conduct a search of all data and information on the needs and requirements for microclimate cooling (MCC) and heating for Navy/Marine personnel in order to develop thermodynamic guidelines for potential endothermic agent(s) to be used as the active component(s) in the environmental control system. The contractor shall select and characterize the most suitable endothermic agents for inclusion in a demonstration system prototype. After a thorough thermodynamic evaluation of the agents, the contractor shall design and fabricate a feasibility demonstration prototype for test and evaluation.

PHASE II: Using the research, development, design, and fabrication initiatives from the prototype development effort, the contractor shall extend the scope of the program to optimizing the configuration for PECS development for both cooling and heating utility. Selection and tailoring of the endothermic agent(s) will be based on the results of test and evaluation of the demonstration prototype. The prototype hardware configuration (a garment design or other) shall be optimized for maximum wearer comfort and thermodynamic utility, while requiring minimum logistic supportability. The product of this phase of the development effort shall exhibit not only an attractiveness to the combat sailor/ Marine, but also demonstrate an attractiveness to the commercial market. Commercial applications shall be identified, and product test samples shall be made available for evaluation by potential users.

PHASE III: Commercialization of the Phase II systems shall be given widest dissemination and exploitation. Market surveys commencing during the Phase II effort shall be completed. Scale-up processes from a preproduction mode to full production of PECS shall be identified and commence as the final transition from combat development to commercial application is made. The end product of this R&D program will provide off-the-shelf commodities for procurement by the military and civilian markets.

COMMERCIAL POTENTIAL: Limited research & development (R&D) into endothermic, phase change transition materials has demonstrated a potential for keeping foods warm for extended periods of time. These materials, having very high thermal capacity and thermodynamic properties (extremely high heats of fusion and specific heat), have already been incorporated into cups, bags, food carts, trays, and related devices. Some commercialization of the technology has already begun, as Pizza Hut, for example, is now using a special tray and heating disk made from these high tech endothermic materials for their delivery service. These disks have demonstrated the ability to maintain a 2-4 pound pizza above 140°F for 90 minutes. Although these endothermic materials have high potential for use in hot water heaters, camping gear, cold weather clothing, boots, fire control applications, and the like, no funding efforts have commenced in these areas. Because these materials are "heat absorbing", undergarments impregnated with endothermic agents could essentially extract excess body heat, exhaust such heat to the external environment, and keep the wearer cooler for extended periods of time. Firefighters, race car drivers, and wearers of protective clothing (nuclear and chemical workers, for example) could substantially benefit from these endothermic materials. In cold temperature environments, the heat absorbed from the body by these materials could be prevented from being exhausted and therefore maintain the body's temperature for a longer period of time. Skiers, skaters, oil pipeline workers, and the like could take maximum advantage of this technology in the heating mode.

REFERENCES:

1. "Answer Looking for a Problem" (Ballistic Missile Defense Office technology development), AVIATION WEEK AND TECHNOLOGY, Vol. 15, June 13, 1994.
2. "A Star Wars Legacy: Hot Pizza", BUSINESS WEEK, Vol. 81, January 17, 1994.
3. "Composite Fabrics Spruce up the Heat Sink", OUTLOOK, July 2, 1984

4. US Patent 4,446,916, "Composite Fabric Endothermic Electronic Component Cooling", May 8, 1984

N95-105 TITLE: High Temperature Corrosion Resistant Coatings

OBJECTIVE: To develop a low cost coating that provides increased corrosion resistance for application on components operating in high temperature environments such as engines and exhaust systems.

DESCRIPTION: The United States Marine Corps has identified corrosion as an ongoing problem area. Higher life cycle costs of equipment, reduced operational availability, and excessive manpower requirements to maintain operability are some of the problems associated with corrosion. Current corrosion control methods, as well as some aspects of weapon system designs, have been identified as Naval requirements. Recent surveys of fleet vehicles have targeted several areas requiring the conduct of research and development of new corrosion resistant materials, coatings and procedures to prevent and combat corrosion problems. One persistent problem found repeatedly throughout the investigation was the general corrosion, pitting and crevice corrosion found on several vehicles' engine and exhaust systems. Typical applications to be targeted include engine exhaust manifolds, exhaust pipes, mufflers, and protective screening. These areas of the vehicle are exposed to severe environments where coatings often fail. Consequently, heavy amounts of corrosion can be found in these areas where coatings either fail or are never applied necessitating the need for a more extensive and durable coating. Exhaust components can experience temperatures as hot as 800°C (1,475° F) adjacent to the engine. Components further along the exhaust system experience 200° C temperatures.

PHASE I: The contractor shall perform research efforts toward developing low cost, corrosion resistant coating that can be applied to components and systems operating in high temperature environments. At a minimum, laboratory experiments shall be conducted during this phase to demonstrate the effectiveness of the coating(s) to withstand high temperatures. The contractor shall host two (2) meetings, a kick-off and mid-term review, at his facility for government personnel. The contractor shall provide a Final Report and final review briefing at the completion of the phase at a government site to be determined.

PHASE II: The contractor shall perform full-scale application and demonstration of the high temperature coating(s) on an actual piece of military equipment supplied as Government Furnished Equipment (GFE). Application techniques shall be determined and demonstrated through experimentation. Testing of the sample component(s) shall be conducted in the laboratory under actual environmental conditions including temperature, humidity, salinity, and exposure to the sun. The contractor shall host status review meetings at his facility approximately every three months throughout the performance period. A Final Report and final review briefing shall delivered at the completion of this phase.

PHASE III: The contractor shall apply the developed coating(s) on six (6) pieces of military equipment (GFE) for extensive field testing to determine the operational suitability of the coatings as they relate to performance, durability and maintainability.

COMMERCIAL POTENTIAL: A cost effective coating that can be applied to components that operate in high temperature environments, that resists corrosion, and that withstands normal wear and tear typically experienced in military applications has enormous potential for the commercial automotive industry. Auto makers, truck manufacturers and producers of marine equipment can benefit from this technology. High precision turbine engine, diesel engine and air compressor manufactures can also benefit. Any application where high temperatures are experienced and dependable coatings are required would gain from this technology.

REFERENCES:
1. Corrosion of Combat and Tactical Equipment on US Marine Corps Bases, CARDIVNSWC-TR-61-94/19

N95-106 TITLE: Radio Frequency Information Dissemination

OBJECTIVE: Develop wireless displays and internet compatible transfer of Radio Frequency (RF) tag information through open communication standards.

DESCRIPTION: Military logistics information systems are being developed using RF tagging technologies. The amount of information being disseminated will require advanced communication systems to interface with existing systems and a sophisticated architecture to handle the information volume.

PHASE I: The contractor shall identify Internet and other transmission and messaging standards for RF communication to low-cost battery-operated tags with built in two-way communication. The study shall compare protocols,

connection and messaging capabilities. The study will address throughput. Information transmission may include inventory data as well as video display for field asset location. The architecture will provide deployed theater users with access to RF information.

PHASE II: The contractor shall prepare a brass-board concept feasibility model and demonstration. It shall demonstrate open RF transmission protocols between tags and interrogators, and remote heads-up displays. Volume data handling will be demonstrated.

PHASE III: The contractor shall prepare a system for suitable testing on a large scale. Transmission protocols will communicate with tens to thousands of tags present within range, while interfacing the information to a variety of identified military systems. Transition will include commercially available system integration components.

COMMERCIAL POTENTIAL: The RF tag which interfaces to large information volume applications will be a benefit to the medical, manufacturing, transportation, and maintenance fields. Item control within wireless local and wide area networks will greatly increase the user ability. Tags will be compatible with the National Information Infrastructure initiatives.

REFERENCES:

1. MIL-STDs 1780, 181, 1782
2. FIPS PUB 1461-1
3. RFCs 1122, 1123, 822

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N95-107 TITLE: Data Link Training and Exercise Coupler

OBJECTIVE: Design and develop a low cost device to couple RF band data link systems via phone lines for use in training, exercise, testing, and development.

DESCRIPTION: Tactical data links use wireless radio communications to connect terminals on land, ships and aircraft. For purposes of training, exercise, testing, development, and potential operational uses it is valuable to be able to link an RF band system, including the host computers served by the terminal, to similar systems at various remote locations around the country or the world. Rather than link systems at such distances by radio frequencies (RF), the proposed coupler would connect to the terminal by coax or fiber at RF, maintaining the high signal to noise ratio. It shall reduce the message traffic to baseband which can be carried over phone lines and connected to similar configurations anywhere in the world. Information describing simulated environments can also be shared via phone lines so that the participating systems seem to be operating together in a common tactical area.

PHASE I: Perform the studies necessary to define design alternatives of a Coupler and develop a preliminary design. The Coupler should be capable of supporting Link 16 fixed format messages. The controlling computer component of the Coupler should be a commercially available microcomputer, preferably an IBM compatible machine. In addition to the radio frequency (RF) interface the Coupler should have a standard serial interface (probably RS-232) over which it will forward data received from the RF interface and will receive data for transmission on the RF interface.

PHASE II: Produce an Advanced Development Model of the Link 16 Training and Exercise Coupler. Demonstrate its functionality by installing and testing the terminal at the Navy's Link 16 Systems Integration Facility (SIF).

PHASE III: The Coupler design will be refined to make it convenient and flexible to use for many military and commercial applications. Cooperative development support will be sought within the Department of Defense and with other interested nations.

COMMERCIAL POTENTIAL: The coupler has applicability to other RF systems for similar long distance test, simulation and training.

N95-108 TITLE: Quantification of Platform Level Mission Effectiveness

OBJECTIVE: To devise a methodology and develop a model for quantifying electromagnetic system degradation effects on platform level mission effectiveness.

DESCRIPTION: In recent years, the Navy's Ship Survivability Program developed generic component, system, and platform

level deactivation models for use in identifying and prioritizing system and platform vulnerability to specific hard kill threats. These models can be expanded and applied to Battle Force simulators to take into account degradation of systems resulting from EMI, and thus meet the important goal of quantifying platform mission effectiveness. Historically, weapon systems have been assessed individually in terms of degradation of performance without regard to platform level mission effectiveness. The need to develop this assessment capability is supported by the aircraft and ship acquisition and operational communities.

PHASE I: To demonstrate feasibility, the basic approach is to, (a) review existing procedures, practices, and models for applicability, and (b) develop, modify, and apply a prototype model to a specific platform application, and (c) demonstrate satisfactory technical results based upon technical and operational experience.

PHASE II: Integrate the developed Platform Mission Effectiveness model into an existing Battle Force simulator and perform technical and operational assessments and validation checks based upon established operationally accepted Measure of Effectiveness (MOE), for a specific ship.

PHASE III: Standardize these methods for applications in commercial navigation and aircraft control.

COMMERCIAL POTENTIAL: Degradation to the Federal Aviation Administration's (FAA) air traffic control system could be modeled using this proposed methodology. This modeling will be particularly important when the new Aircraft Automated System (AAS) is brought on line. The potential threat with respect to air traffic control are conventional and directed energy terrorist weapons.

N95-109 TITLE: Milstar MDR - Network Bridge

OBJECTIVE: Develop protocols for bridging and multiplexing EHF MDR terminals with advanced networks.

DESCRIPTION: Investigate, develop and demonstrate efficient algorithms and protocols to multiplex and interface EHF MDR terminals to advanced networks (such as Asynchronous Transfer Mode/Synchronous Optical Network systems) thereby providing EHF terminal user's access to medical imagery, photography, and fixed site locations while maintaining system security.

PHASE I: Develop the algorithms needed to efficiently bridge and multiplex Milstar MDR terminals with a packet switched network.

PHASE II: Code and demonstrate algorithms using commercial hardware needed for the MDR/ATM interface.

PHASE III: Build and demonstrate the complete interface.

COMMERCIAL POTENTIAL: Protocols can be used for connecting other digital satellite systems (e.g., Iridium) with advanced networks.

REFERENCES:
1. MIL-STD-1582C, "Satellite Data Link Standards: Uplinks and Downlinks" 10 Dec 91.
2. MIL-STD-188-136, (coordination draft), "Satellite Data Link Standards, Medium Data Rate (MDR), Uplinks and Downlinks" 07 Mar 94.

N95-110 TITLE: Demodulation of Signals Localized by Super-resolution Array Processing Techniques

OBJECTIVE: Explore signal processing techniques which permit reconstructions of signals decomposed by super-resolution array processing techniques.

DESCRIPTION: In a dense signal environment, co-channel interference occurs when two communication signals transmit simultaneously in the same segment of the frequency spectrum. Intentional jamming of radar or communication signals also represents an example of co-channel interference. The use of arrays of antennas to direct radiation pattern nulls provides one approach to the rejection of interferers. When the direction of arrival of an interfering signal is very close to the direction of arrival of a signal of interest (e.g., beamwidths) super-resolution techniques provide means of distinguishing between signals. Unfortunately, most super-resolution techniques discard phase information necessary to demodulate communication signals. Means of separating and demodulating closely spaced signals is of interest.

PHASE I: Identify candidate approaches for separating and demodulating signals transmitted by closely spaced co-channel emitters. Possible approaches may include, but are not limited to, extraction from original, unprocessed data of phase information for signals distinguished by super-resolution; cyclo-stationary approaches to array and signal processing; or array

processing techniques employing higher order statistics.

PHASE II: Implement and, using realistic simulations, demonstrate best approach(es). Evaluate approach(es) with regard to computational intensity, spatial resolution and quality of demodulated desired signal (e.g. bit error rate).

PHASE III: Apply array processing technology to appropriate communication systems.

COMMERCIAL POTENTIAL: Interference rejection presents an important challenge to the burgeoning cellular telephone industry.

REFERENCES:
1. Freeman, Roger L., "Telecommunication Transmission Handbook, Third Edition", John Wiley & Sons, Inc., 1991.

N95-111 TITLE: Multiple, High Bandwidth Light Weight Satellite Communications (SATCOM) Antenna

OBJECTIVE: Development of a small, light weight multiple band phased array high bandwidth satellite antenna system capable of operating in the UHF, C and Ku bands, SHF and EHF frequency ranges. Dual to multiple band operation is desired. The antenna system is for shipboard use and Very Small Satellite Access Terminal (VSAT) computer communications from small ships and planes.

DESCRIPTION: NRL currently has an ocean buoy system capable of transmitting/receiving data, via commercial satellites operating in the C & Ku bands, to one or more land sites at data rates in excess of 1.5Mb/s. To accomplish this, the buoy currently uses a parabolic dish antenna system 1.2m in diameter. This relatively large size limits deployment opportunities. Miniaturization technology could be employed to reduce antenna size to perhaps as little as 100 square cm, allowing the system to be easily air deployable and deployable from small ships while still operating in the current frequency ranges.

PHASE I: Develop the basics of a phased array antenna system able to operate within the constraints described above.

PHASE II: Develop a prototype antenna to demonstrate the capabilities, size limitations, and bandwidths of phases array technology.

PHASE III: Produce a phased array antenna capable of withstanding the rigors and requirements of at-sea deployments on ships or buoy systems.

COMMERCIAL POTENTIAL: Development of this capability could expand the portable communications market by making worldwide high bandwidth communication possible.

N95-112 TITLE: Graphic CASE Tools for INFOSEC Threat and Risk Analysis

OBJECTIVE: To permit security requirements and associated threats and risks for Navy C4I systems to be quickly captured and displayed during initial sponsor/developer/accreditor negotiations.

DESCRIPTION: Existing CASE tools for INFOSEC risk analysis are designed for trained certifiers and are generally not suitable for initial high-level (non-jargon) evaluation of system security approaches. However, designing new CASE tools to meet this need appears prohibitively expensive and time-consuming. The Navy would like to explore the adaptation of existing (non-INFOSEC) CASE tools with good graphical system display capabilities and expert system shells to be effective trade-off and negotiation vehicles.

CASE tools for INFOSEC threat analysis do not exist, and available threat information is disjoint and extremely difficult to use by either trained certifiers or by high-level decision makers. An initial Navy effort, begun in FY 94, has an objective of building a prototype Tailored Threat Profile tool. That tool will contain a database of actual attacks against Navy systems (or analogous systems). When queried, the tool will ask for high-level descriptive data about the proposed system and then return a profile of likely threat scenarios. However, the prototype system will not show a graphical description of the proposed system nor use an expert system shell to reason about likely threat scenarios. The Navy would like to explore the adaptation of existing (non-INFOSEC) CASE tools with good graphical system display capabilities and expert system shells to build a follow-on to the initial prototype.

Modified CASE tools for INFOSEC threat and risk analysis are needed that will capture and display:

a. the system itself with major subsystems and components;
b. the environment that the system operates within;
c. the importance of the system and the information it handles;

d. interfaces to the system (both human and otherwise) with some indication of their trustworthiness;

e. potential threat scenarios; and

f. assumptions and assertions about the existence of INFOSEC protective features (either in the system or in the operating environment).

The output of the INFOSEC threat tool will be a graphical view of the system showing the most likely (if any) threat scenarios. The output of the INFOSEC risk analysis tool will be a graphical view of the system showing the agreed-to set of system and environmental protective features that represents the negotiated INFOSEC approach (ie. acceptable risk, acceptable cost, acceptable program/technical implications).

PHASE I: Define problem, select and demonstrate existing CASE tools, scope and plan required modifications.

PHASE II: Accomplish and demonstrate modified tools suitable for Navy C4I systems. Support government beta testing. Modify tools as appropriate.

PHASE III: Expand tool libraries beyond initial C4I capability. Produce tools as commercial products.

COMMERCIAL POTENTIAL: These analysis tools would prove very useful for non-defense commercial organizations, especially in the financial and medical industries where disclosure, modification, or destruction of sensitive information could cause a great amount of damage. These tools would help such organizations to identify potential threats and risks to their information assets and address them appropriately.

N95-113 TITLE: Coarse-Grained Parallel Desktop Computing System for Enhanced Image Processing

OBJECTIVE: Development of a high performance, coarse-grained parallel workstation to process sensor data.

DESCRIPTION: Desktop computer workstations are sought that contain 4 to 16 CPUs capable of operating in parallel and providing multiple GigaFLOP performance for image processing applications. These CPUs should also possess large associated internal memories to support the processing of large sections of individual images. Very large data storage systems with capacities in excess of 10 Gigabytes are desired for image processing applications. These systems must have data access times and transfer rates that meet or exceed current desktop computer hard disk specifications. The integration of memory devices such as PC-MCIAs for transferability and security into memory is desired. New visualization techniques are sought for the optimal presentation of the 2-D and 3-D transformed images resulting from the advanced signal and image processing algorithms. An integrated Operator Machine Interface (OMI) is desired that links features automatically detected in the transformed images back to specific features in the original images. This MOMI should be sufficiently generic so that imagery of various types ranging from X-ray to satellite images can be displayed at appropriate resolutions. The capability of simultaneously displaying multiple resolution screens (hyper color) is required. Workstations of this type will have many possible defense and commercial applications in areas such as automated screening of medical or satellite imagery.

PHASE I: Design a scale able, coarse-grained parallel computer workstation architecture capable of at least two GigaFLOPS of performance and having at least 0.5 Gigabytes of RAM. An integrated OMI design complete with associated documentation. A limited demonstration involving two different types of images (X-ray, MRI, etc.) combined with associated images resulting from two or more signal or image transformations of interest is also required at the completion of Phase I. Document this design and demonstrate a prototype at the completion of Phase I.

PHASE II: Extend the Phase I design to produce an enhanced version with at least 20 GigaFLOPS, 2 Gigabytes of RAM, and the ability to store 500 one byte 8" X 10" images with a resolution of 500 pixels per inch. Image processing at 1/8 real time is required. Real time processing is desired. Implementation the Phase I OMI design on a designated coarse-grained parallel computer system and extend the number of image types handled to a minimum of six, based on government provided data sets.

PHASE III: Transition this technology to appropriate defense and commercial sensor data collection, sensor data analysis, and sensor communications applications.

COMMERCIAL POTENTIAL: The primary commercial applications of this technology are in automatic rapid computing for mass screening of medical images for conditions requiring physician follow up and automatic rapid computing for material flaws (non-human screening) in mass produced items (i.e. non-destructive testing).

REFERENCES:

1. Digital Image Processing, by Raphael C. Gonzalez and Riochard E. Woods, Addision-Wesley, 1992.
2. Illumination and Color in Computer Generated Imagery by Roy Hall, Springer-Verlag, 1988.
3. Computer Graphics: Principles and Practice, by James D. Foley, Andries Van Dam, Steven K. Feiner, and John F. Hughes,

Addison-Wesley, 1990.
4. Deans, Stanley R., *The Radon Transform and Some of Its Applications,* rev. ed., 1993, Krieger.
5. Bracewell, R. N., *The Fourier Transform and Its Applications,* 2nd rev. ed., 1986, McGraw.

N95-114 TITLE: Virtual Information Model (VIM)

OBJECTIVE: To adapt emerging video, message and model-modifying techniques for the exchange of hybrid data over existing land and satellite links to and from fleet units. This initiative will unburden the need for bandwidth by transferring only previously unknown data: simple, clear, accurate and timely descriptions of complex changing situations and environments could be exchanged without the consequences of voluminous and overloading data streams.

DESCRIPTION: This task will develop a prototype system optimizing an amalgam of commercial video formats and protocol, Defense Mapping Agency derived models, supplying movable windows with zoomable video, audio and data panes, and operational message formats. The fundamental feature sought is the transfer of hybrid change information of an operational scene (depicted by structured video images, audio transmissions and operational message traffic) to a remote system containing the same initial structure but requiring change data to remain identical. This schema would enable short, quick packets of data in real time to reduce overall traffic demands and use low point-to-point bandwidth.

PHASE I: Conduct a trade-off analysis of existing or low-risk emerging techniques. Insert higher risk techniques with innovative risk reducers into the analysis for optimizing payoff. Provide a short demonstration using PC to PC remote connection, CD-ROM resident scenarios (15 to 30 minutes) with externally selected naval engagement overlays. Proposer may offer an alternative means of demonstration. Apply metrics to compare traditional and model-modifying techniques.

PHASE II: Implement a sender-to-user workstation environment based on the video/audio/message structures designed in Phase I for an initial evaluation at a Navy facility such as Naval Command Control and Ocean Surveillance Center (NCCOSC). Introduce one or more commercially viable scenarios. Stress the model to bandwidth and complexity limits.

PHASE III: The successful use of modelling would lead to low-cost interim pathways pending the implementation of the anticipated "super-highways" connecting global networks. Applications for the telecommunications industry are myriad.

COMMERCIAL POTENTIAL: It is anticipated that this approach will become as profound a capability commercially as militarily, a "force multiplier" for more advanced data links in future, capturing multiple and user-controlled data panes. The technique would be applicable to tactical links, command and control summaries, traffic control, situation displays, and both military and commercial global surveillance (geological, agricultural).

REFERENCES:
1. IEEE Spectrum, March 1992.

N95-115 TITLE: Expert System Tactics Representation

OBJECTIVE: Develop reusable, object oriented, expert system software capable of capturing the human tactical decision processes associated with the employment of Naval platforms, sensors and weapon systems, and reproducing them within campaign and engagement level discrete event warfare simulations.

DESCRIPTION: Current campaign and engagement level discrete event warfare simulations generally represent the tactical decision processes associated with the employment of platforms, sensors and weapon systems in manners that are highly dependent on both the simulation system and the scenario. Frequently the decision processes are fully scripted or are represented by scenario dependent logic trees or rule sets. Such approaches, although computationally efficient, require extensive setup and over no potential for portability between simulations or scenarios. The object oriented paradigm offers the possibility of a sophisticated, reusable expert system capable of capturing and reproducing the tactical decision process at the entity level. Coupling such a system to a generalized schema for the representation of tactics offers the opportunity for maximum reuse and portability across simulations and scenarios. Critical capabilities include superior run time efficiency to support Monte Carlo analyses and the ability to readily modify the knowledge base during run setup.

PHASE I: Develop a partial schema for the representation of platform/system level tactics leading to the development of a sample knowledge base. Demonstrate the sample set with a prototype expert system.

PHASE II: Expand the knowledge base schema to support the tactical decision processes associated with a spectrum of Naval platforms, sensors and weapon systems. Incorporate the expert system into an existing campaign or engagement level

warfare simulation and demonstrate its function with a sample problem.

PHASE III: The developed expert system will be applied to additional warfare simulations.

COMMERCIAL POTENTIAL: The technology has application to all discrete event simulations used to analyze the performance of complex systems that are affected by human decision processes, including financial and sociological models.

N95-116 TITLE: Global Positioning System (GPS) Integrity Monitoring

OBJECTIVE: Develop improved Receiver Autonomous Integrity Monitoring (RAIM) algorithms for GPS integrity monitoring which can detect integrity failures that result from error drifts over time rather than instantaneous anomalous events. Further, investigate the utility of low cost inertial sensors to aid GPS integrity monitoring. The objective would be to utilize solid state inertial sensors which can be placed on the same electronic card as the GPS receiver.

DESCRIPTION: GPS receivers must be able to detect and reject satellite signals that lead to unacceptable position and velocity errors. Current RAIM algorithms do not have the sensitivity to detect small and slowly varying anomalies. The technical approach shall include detection of small and slowly varying errors in the RAIM algorithms. A second approach to be investigated will use solid state inertial sensors. The utilization of precise multi-satellite GPS delta range measurements should allow accurate estimates of changes in attitude over small intervals. A comparison of the change in attitude over a given time interval as determined by the GPS delta-ranges and the inertial sensor will yield information on the degree that they are tracking each other.

PHASE I: Design and simulate a RAIM algorithm to include detection of small time varying errors. Algorithm performance will be investigated and compared with other RAIM approaches. Conduct a 6 month study to determine the latest available requirements and augmentation plans for non-precision and precision approach integrity monitoring. Develop/adapt models for multi-sensor low cost inertial sensors. Develop algorithms relating inertial sensor outputs and GPS receiver outputs for representative approach dynamic scenarios. Determine observability issues. Perform simulations indicating comparisons on attitude change indications from inertial vs. GPS for various levels of anomalous signal-in-space failures. Paramaterize simulations about levels of sensor performance, relative geometry, lever arms, and dynamic profile.

PHASE II: Prototype build and demonstration. Develop and integrate a real-time GPS RAIM algorithm. The real-time algorithm will be integrated with standard aircraft navigation functions and evaluated in a laboratory environment.

PHASE III: Support design and build of ruggedized unit. The RAIM algorithm will be translated to hardware and flight tested.

COMMERCIAL POTENTIAL: The technology has applicability to the commercial aircraft navigation industry. Can be directly used for integrity monitoring for civil aviation.

N95-117 TITLE: Advanced System Trainer

OBJECTIVE: To develop and test an intelligent tutoring system to replace/reduce traditional, labor intensive classroom and team training.

DESCRIPTION: Develop an intelligent tutor focused on conceptual understanding and problem solving skills rather than on procedural behaviors. The intelligent tutor should accurately and efficiently diagnose any trainee's background from responses to curriculum material and should use that diagnosis to adapt and streamline the curriculum presented to that trainee. (i.e. The tutor should automatically determine any individual's training requirements and adapt the training material and skill/comprehension level for optimum individual learning.) The intelligent tutor must present training in a manner to capture the trainee's interest and must run on commonly available hardware.

PHASE I: Examine various innovative methods to automate training. Develop the methodology for replacing team training with individualized computer based training. Outline the structure of an intelligent computer based tutoring system. Describe the knowledge base required by the tutor. To delineate the knowledge base use SURTASS LFA deployment, ADS Operations, or IUSS Operational Readiness Inspections as the target training systems for the tutor.

PHASE II: Develop and test a prototype Advanced training System. The prototype should validate the man-machine interface and the trainer's design approach. The prototype need not implement an actual training capability. Provide cost and schedule estimates for developing a fully capable advanced training system.

PHASE III: Develop and test a fully capable advanced training system.

COMMERCIAL POTENTIAL: The technology developed by this SBIR is equally applicable to other government (e.g. FAA) and commercial training requirements. Changes to adapt the Advanced Training System to these other training requirements will be localized in the knowledge data base.

REFERENCES:

1. Tailored MIL-STD-1379D, Military Training Standards; Multi-Media Embedded Training

N95-118 TITLE: Advanced Signal and Image Processing Algorithms for Parallel Desktop Computing

OBJECTIVE: To develop and demonstrate and advanced signal and image processing detection and alerting application for sensor system data.

DESCRIPTION: Advanced signal and image processing algorithms are sought for 1-D, 2-D, and 3-D image analysis to take advantage of expected advances in high throughput, parallel desktop computing systems. Simultaneous processing using multiple algorithms is desirable. Of particular interest are those transform algorithms that generate signal invariances. This includes invariance under translation, rotation, scale changes, polarization changes (if applicable), etc. Neural networks and expert system approaches are needed for automated feature detection, extraction, and classification from 2-D and 3-D transformed images. Development of these capabilities with low false dismissal rates would allow significant advances in automated image screening. Many areas of interest to both the military and industry require the analysis and evaluation of imagery data. Approaches of highest interest would allow automated screening of large numbers of images, provide for automated alert generation followed by operator review and analysis, allow for multiple scale neural net retinas, provide tools for rapid neural net training, allow for the use of hierarchial networks to aid fusion across multi-spectral representations, and utilize expert system rules for data fusion and false alarm reduction. Examples range from feature detection in X-ray, MR, and ultrasound medical images through non-destructive fault detection in hand-made parts and structures to feature recognition in satellite imagery. The development of advanced signal and image processing algorithms capable of generating transformed and enhanced 2-D or 3-D images in near real-time is of great interest. Any algorithms developed should be capable of being generalized to any type of image or any type of data (e.g., real, complex, etc.). Of particular interest are those transformations that result in either a more simplified feature set or signal invariance. Possible candidate algorithms include: 2-D and 3-D FFTs, wavelets, Gabor functions, and Radon/Hough transforms. Software applications that can be hosted (compiled) on today's high parallel desktop computers will have many possible defense and commercial applications.

PHASE I: A number of these algorithms are to developed using a rapid prototyping approach. This effort shall represent a proof-of-principle demonstration. Associated documentation is to be provided. These algorithms are to be evaluated on at least two government provided data sets of interest in order to quantify their ability to enhance visual detectability of important features. Multiple resolution scales and multiple spectral images should be considered in the evaluation. The ability to run multiple algorithms in parallel for comparison is highly desirable. The performance of the neural net detection and classification algorithms shall be evaluated and the performance documented in the form of ROC curves.

PHASE II: During this effort, at least six additional government provided data sets shall be evaluated to demonstrate the usefulness of these algorithms on a wide range of image types. Efforts shall also be made to ensure that all algorithms can be run at near real-time speeds. A speed of 1/8 real time is required while real time is desirable. Neural net training tools shall also be developed as part of this effort.

PHASE III: Transition this technology to appropriate defense and commercial sensor data collection, sensor data analysis, and sensor communications applications.

COMMERCIAL POTENTIAL: The primary commercial applications of this technology are in automatic rapid or mass screening of medical images for conditions requiring physician follow up and automatic non-human screening for material flaws in mass produced items (i.e. non-destructive testing).

REFERENCES:

1. Digital Image Processing, by Raphael C. Gonzalez and Riochard E. Woods, Addision-Wesley, 1992.
2. Illumination and Color in Computer Generated Imagery by Roy Hall, Springer-Verlag, 1988.
3. Computer Graphics: Principles and Practice, by James D. Foley, Andries Van Dam, Steven K. Feiner, and John F. Hughes, Addison-Wesley, 1990.
4. Deans, Stanley R., *The Radon Transform and Some of Its Applications,* rev. ed., 1993, Krieger.
5. Bracewell, R. N., *The Fourier Transform and Its Applications,* 2nd rev. ed., 1986, McGraw.

N95-119 TITLE: Increased Data Throughput on EHF SATCOM

OBJECTIVE: Design, develop and demonstrate a low cost EHF SATCOM baseband VME processor capable of providing an adaptive processing gain of greater than 10 dB. Processor operation must be automatically scalable from data rates of 300 bps up to 1.5M bps to accommodate arbitrary EHF capacity segmentation.

DESCRIPTION: EHF SATCOM is poised to become a critical backbone for Navy Fleet communications. As such, it must be able to provide reliable service under a broad range of conditions, including: benign conditions, atmospheric scintillation, rain attenuation, interference, jamming and service to disadvantaged platforms. What's needed is an adaptive processor which can operate with reduce link margin and still provide additional processing gain when needed by (adaptively) reducing the user information rate to match channel conditions. When conditions are good, the processor should provide a user data rate close to the channel rate, imposing little overhead. The processor should also support both point-to-point and point-to-multi-point communications.

PHASE I: Define the scalable, adaptive processor, specifying the processing it will perform and a hardware architecture capable of supporting this processing. Also, specify how the processor will be integrated with the Navy EHF Communications Controller (NECC).

PHASE II: Develop and demonstrate prototype scalable, adaptive processor.

PHASE III: Integrate the scalable, adaptive processor with Navy EHF SATCOM terminals.

COMMERCIAL POTENTIAL: The technology to be developed would extend the "footprint" covered by commercial satellite links and allow remote mobile terminals to connect reliably to wideband networks, e.g., ATM networks.

N95-120 TITLE: Single Channel Acoustic Broadband Classification

OBJECTIVE: To develop single channel/beam acoustic broadband classification algorithms and techniques.

DESCRIPTION: The objective of this topic is to develop single channel/beam acoustic broadband classification algorithms and techniques. A further goal of this topic is determine the bandwidth of each broadband "swath" of energy associated with a particular target in the channel or beam. Proposals shall address specifically proposed algorithms and fully describe techniques to be employed and tested. Specifically the proposed test procedures will address how the algorithm perform as a function of Signal to Noise Ratio (SNR) i. e. the procedures to develop Receiver Operating Characteristics (ROC) curves shall be fully described. It is expected that the algorithms will perform at SNR's of less than +5dB per frequency-time cell with a probability of detection (Pd) of 0.5 and a probability of false alarm (Pfa) of less than 0.0001. The method or procedure for maximizing the SNR for each frequency-time cell shall be fully described in the proposal.

PHASE I: A demonstration of the proposed algorithms and techniques using GFI Advanced Deployable Systems (ADS) data will be performed. Results of all tests as well as ROC curve data will be reported. Specifications for the algorithms, techniques, and procedures shall be developed and delivered.

PHASE II: The algorithms, techniques, and procedure will be optimized and implemented on a computer workstation such as DTC III or IV. Further testing with GFI ADS data will be performed and reported. A full and complete description of all algorithms, techniques, and procedures will be reported and an A level performance specification developed.

PHASE III: A potential contract award as an ADS subcontractor to the prime contractor in the post DEM VAL ADS program time frame to integrate the algorithms, techniques, and procedures for broadband classification into ADS or SURTASS.

COMMERCIAL POTENTIAL: This development has the commercial potential in non-destructive testing to detect incipient failure in rotating machinery components.

REFERENCES:
1. Theory and Application of Digital Signal Processing, by Lawrence R. Rabiner and Bernard Gold, Prentice-Hall, Inc. 1975.
2. Digital Image Processing, by Raphael C. Gonzalez and Richard E. Woods, Addison-Wesley, 1992.
3. Scientific Visualization, Techniques and Applications, K. W. Brooke et al., Springer-Verlag, 1992.
4. Mission Needs Statement for Undersea Surveillance in Littoral water of 18 March 1993.

N95-121 TITLE: Multi-Band Radar for Ocean Characterization

OBJECTIVE: Develop a multi-band radar capability and associated software to discriminate ocean features.

DESCRIPTION: Ocean characteristics, particularly in the near-coastal/littoral zone are of critical interest to the U.S. Navy for mission planning and tactical decision making. New methods for determining these characteristics need to be developed. Because radar signal response to ocean roughness is a function of radar frequency, a multi-band radar system (e.g., S-, C-, X, and Ka bands) could be used to characterize the ocean surface and discriminate significant surface features. Various ocean features such as convergence and shear fronts, films (thick or thin, natural or artificial), and internal waves can be measured using radar scatterometry techniques. Suitable algorithms to extract and analyze data from a multi-band radar system also need to be developed.

PHASE I: Assess possible alternatives for a multi-band radar system and associated software to derive ocean characteristics based on radar signal response to ocean roughness and propose a candidate system design.

PHASE II: Assemble and test a prototype multi-band scatterometer. Develop analysis algorithms. Test the prototype system. Collect and analyze data and modify algorithms accordingly.

PHASE III: Transition the multi-band radar system to air and space-borne platforms for operational use.

COMMERCIAL POTENTIAL: Oil spill detection, characterization and source location.

NAVAL AVIATION SYSTEMS TEAM

N95-122 TITLE: Frequency Domain GPS Receiver

OBJECTIVE: Develop a frequency domain GPS receiver that will track code and carrier at extremely high accelerations, acquire track very quickly, resist jamming and mitigate multipath.

DESCRIPTION: Conventional GPS receivers are based on delay lock loops, which have inherent limitations in tracking very high accelerations and are also susceptible to multipath and jamming. With the advent of very high speed Digital Signal Processing (DSP) techniques, current technology exists to design GPS receivers with signal processing done entirely in the frequency domain. Although GPS receivers are currently capable of tracking code phase up to 90 g's, they require significant aircraft power and pod rail space. Alternative digital signal processing, such as the fast wavelet transform, may yield a more efficient processing algorithm. Wavelet or other new technology algorithms may allow the decomposition and analysis of GPS signals to filter out unwanted multipath or jamming signals. This type of GPS receiver must output position solutions in real time, be capable of hardware miniaturization, and consume small amounts of power.

PHASE I: Investigate the feasibility and efficiency of DSP techniques for GPS receivers applicable to tracking both code and carrier at very high accelerations, very fast acquisition, multipath reduction, and increased resistance to jamming. The DSP algorithms must be demonstrated through analysis and prototype development. Potential architectures will be investigated to demonstrate a suitable platform with minimal power consumption that can be miniaturized.

PHASE II: Develop, test, and operationally demonstrate the GPS DSP receiver methods formulated under the Phase I SBIR effort.

PHASE III: Verify producibility through low rate initial production.

COMMERCIAL POTENTIAL: New GPS DSP methodology can be used for commercial aircraft and differential base stations that would benefit from filtering out multipath and jamming signals.

N95-123 TITLE: 32-Bit High Throughput Processor/Emulator Chip

OBJECTIVE: Increase the effectiveness of platform upgrades (e.g., F/A-18 E&F) through the application of a 32-bit processor/emulator chip.

DESCRIPTION: The Navy currently uses 16-bit mission computers some with built-in 32-bit risc processors. Future requirements will demand more use of 32-bit processing and even grow to 64-bits. This project is to demonstrate a 32-bitprocessor/emulator chip which can directly execute existing AN/AYK-14 code and/or MIL-STD-1750 code.

PHASE I: Provide a feasibility study which analyzes technology, industry projections and emerging products leading

to the design and demonstration of a modular 32-bit processor which can directly and efficiently execute AN/AYK-14 and/or MIL-STD-1750 source code. Particular attention should be given to the at sea operational environment for naval aircraft.

PHASE II: Develop, test and operationally demonstrate the modular processor/emulator identified during the Phase I SBIR effort including the ability for self test, if feasible.

PHASE III: Produce the modular processor/emulator demonstrated in the Phase II effort. Includes transition to other Navy programs such as the AN/AYK-14, F/A-18 E&F P^{3}I, others which currently use AN/AYK-14 or MIL-STD-1750.

COMMERCIAL POTENTIAL: Direct application to commercial versions of the AN/AYK-14 and MIL-STD-1750 computer families.

REFERENCES:

1. MIL-E-5400 Class 2
2. MIL-E-16400 Class 2
3. AN/AYK-14 Source Code
4. MIL-STD-1750 Source Code

N95-124 TITLE: Innovative Solid-state Blue or Blue-Green Laser

OBJECTIVE: Develop innovative, solid-state laser(s) having wavelengths in the range from 470-520 nm to better match the optimum transmissivity of seawater.

DESCRIPTION: The Navy is currently developing non-acoustic (electro-optic) sensors for use in various missions from air platforms. Solid-state lasers are essential to meet the packaging required for operation from Navy aircraft, due to size, weight, and power efficiency considerations. To-date, the only solid-state lasers meeting the packaging constraints operate at wavelengths which do not match the optimum for maximum transmission in seawater. Limited testing with gas and dye lasers have shown there to be a substantial benefit from operation at optimum wavelengths. Recent research in industry has shown the potential of developing new laser technology which will produce output in the desired wavelength range. The development of such lasers will substantially increase the capability of such non-acoustic sensors to meet Navy operational needs.

PHASE I: Demonstrate, using laboratory breadboard equipment, basic materials parameters necessary for operations of the desired laser. This demonstration will include laser spectroscopy testing to determine optical gain in the material, and a determination of the net lasing efficiency to be anticipated in Phase II. Perform a feasibility study to determine the optimum pump, cavity, and lasing material configuration for Phase II.

PHASE II: This phase is further subdivided in two parts:

PHASE IIA: Using the feasibility study performed in Phase I, construct an operating breadboard laser. Using this laser, evaluate performance, including particularly net power efficiency, output stability, and performance envelope as a function of pulse repetition rate. Perform scaling study to determine the optimum laser configuration to proceed to Phase IIB.

PHASE IIB: Building on the previous work, perform engineering necessary to demonstrate a brassboard laser having the requisite performance characteristics to meet current Navy requirements. For the purpose of this topic, this is to be interpreted as a minimum of 10 Watts average power at a pulse repetition rate of 40Hz or greater.

PHASE III: Perform the engineering necessary to productize the laser in a configuration providing optimum power efficiency and minimum packaging volume. This will be transitioned into the NAASW program.

COMMERCIAL POTENTIAL: There is a substantial existing market for lasers having output in this wavelength range. This laser, because of its smaller size and greater power efficiency, is expected to displace existing laser technology in some of these applications, and to create other applications which present lasers cannot fill due to weight, size, and power constraints. In particular, lasers in this wavelength range are frequently used in opthamology.

REFERENCES:

1. MIL-STD-1425

N95-125 TITLE: Radar-Sonar Data Fusion for Clutter Suppression Improvements in Shallow Water Submarine Detection and Classification Performance

OBJECTIVE: Provide a demonstration of quiet submarine detection and classification performance improvement in shallow

water obtainable by data fusion of coincident radar and sonar scattering data to reduce the false alarm rate in both sensors.

DESCRIPTION: Detection and Classification of Quiet Submarine Targets in Shallow Littoral ocean areas to support combined operations with integrated intelligence information communications can be improved by exploiting the complementary nature of Low Frequency Active (LFA) acoustic sensor data and collocated radar maps of surface shipping. Active acoustic sonar returns are often dominated in shallow water environments with multi-path reverberations reflected from bottom surfaces of variable reflectivity and sea water thermal layers with time variable scattering properties - making operator detection of target returns and distinguishing them from clutter reflections from surface ships quite difficult. Superposition of radar knowledge of surface ship positions on an acoustic tactical plot should allow noise and clutter suppression in the acoustic signal data (by screening out sonar scattering signals emanating from radar identifiable large radar crossection (rcs) surface ship locations) with the potential for significantly reducing the sonar false alarm rate. Conversely integration of acoustic source classification and positional information with the radar tactical picture may facilitate the process of distinguishing short time, small rcs periscope detection radar returns from the brown water clutter produced by small boats and floating trash. Integrated passive and active acoustic classification/range/bearing and Doppler information should be useful here when effectively coupled with radar rcs/range/ bearing and Doppler information as evidence of transient radar contact identity.
Accurate data fusion of disparate data from multiple sources of differing resolution, timeliness and confidence into a single self-consistent tactical data frame will best be accomplished through registration of sensor coordinate systems with a common GPS space time data frame. Innovative techniques are needed for data fusion processing which can handle low and variable precision asynchronous acoustic and electromagnetic multi-sensor data derived from distributed heterogeneous processors. This data fusion process must filter noise and clutter, extracting and combining salient information from active and passive systems to develop a single accurate self-consistent tactical picture of target tracks. Algorithms should be scalable to real time operation on an existing computer architecture (eg. a parallel array processor with as many as 32 nodes, each with no more than 64 megabytes of memory).

PHASE I: Design and develop a data fusion algorithmic software system which will be able to demonstrate candidate radar/sonar data fusion algorithm performance under parametrically varying signal to noise & clutter conditions; as a part of this algorithm design effort devise integrated data fusion algorithms appropriate to handle typical shallow water propagation conditions, variable environmental/weather conditions and cluttered operational conditions using GFI Navy standard propagation/noise and clutter models to the greatest extent possible. Determine the feasibility of significantly improving detection & classification performance with data fusion clutter reduction techniques.

PHASE II: Implement a simulation of the data fusion algorithmic system designed in phase I using GFI support software and hardware to the greatest extent possible (eg. the MASS program data fusion simulation software driver and GFE Sun 4 work stations) and test algorithmic processing performance under typical operational conditions using digitized recordings of integrated multi-sensor sea data when available as GFI.

PHASE III: Transition to Navy ASW platform and implement optimally performing algorithms in militarized computer environment (eg. USQ-78A)

COMMERCIAL POTENTIAL: The capability of taking two sensors and integrating the results for improved performance is useful in the medical community. By using both active and passive (for example ultrasound and audio), there would be increased accuracy's in diagnoses.

REFERENCES:
1. Oceanographic and Atmospheric Master Library Summary, Naval Oceanographic Office Report No. OAML-SUM-21B January 1992.
2. Copernicus Project Phase 1 Report, OP-94, Aug 1991.

N95-126 TITLE: Rugged CD-ROM Optical Disk Drive

OBJECTIVE: Develop an affordable CD-ROM optical disk drive system architecture for operation in harsh environments.

DESCRIPTION: CD-ROM has becoming a very affordable and popular means of distributing large volumes of electronic information. There have been a number of proposed military applications which require the use of a ruggedized CD-ROM drive. The commercial marketplace has, until now, been unwilling to address this need. Data that does not change frequently such as digital maps and maintenance data, would be stored and accessed directly from a rugged CD-ROM. The drive shall be utilized for shipboard, airborne, and fielded applications. The CD-ROM drive shall have the ability to withstand harsh land based environments such as desert and arctic conditions and be designed for use in battlefield situations on board fighter aircraft,

RPV's, small ships, tanks, and land vehicles. It shall have the ability to read standard IEC 908, ISO-10149, ISO-9660 CD-ROM media (120, 90mm) as well as CD-Recordable technology.

The completed drive would be capable of meeting or exceeding the following baseline specifications:

* Capacity 650 MB	* Operating altitude to 80,000 ft
* Multi-Session,Multi-Media Compatible	* Humidity - 95%
* 2 X Transfer Rate	* Operational vibration - 6 Grms from 20 to 20,000 Hz
* -20_C to +71_C Operating Range	* Shock 30 g's for 11 msec Survival

PHASE I: Phase I would consist of an investigation of the technology-status of suitable digitally adaptive electronics, a plan to modify and/or design a CD-ROM deckplate for use in military optical disk systems, and developing media protection plan methods for harsh environments.

PHASE II: Phase II would consist of fabrication of a mechanical transport with MIL-E-5400 equivalent anti-shock housing and vibration isolation system, provide mechanical integration and mechanical integrity tests, and provide a complete electronic system design consisting of controller and READ/WRITE electronics, optical head and servo system. Thorough environmental testing would be accomplished on the completed unit with delivery of two prototype flight systems, test reports, instruction manuals, and other documentation.

PHASE III: Produce the ruggedized CD-ROM drive demonstrated in the Phase II effort. Transition efforts will include incorporating the drive into existing aircraft platforms.

COMMERCIAL POTENTIAL: Current audio CD players in cars do skip occasionally resulting in a loss of bits of data. This is rarely noticed in music. Forecasts in the Intelligent Vehicle Highway technology indicate that a CD-ROM optical disk drive system in the future will not be able to afford to drop even a bit of data without affecting the performance. Applications would include digital mapping, travel advisories or emergency information and numbers. Commercial airlines are also exploring the use of CD-ROMs for on-line technical manuals and information which, again, will be more sensitive to dropped bits.

REFERENCES:
1. ISO-9660
2. ISO-10149
3. MIL-SPEC 2036 (Modified and Ruggedized Commercial Off-the-Shelf)

N95-127 TITLE: Ultra High Speed Processor

OBJECTIVE: Increase the throughput of image and/or other sensor processing through the application of cost effective ultra high speed processors which are application specific.

DESCRIPTION: Future naval applications may require the ability to process imagery and other data at extremely high rates in order to form real time perspective or three dimensional scenes. Electronics technology and associated design aids are progressing to the point where it is feasible to develop and demonstrate application specific processors which are capable of throughputs meeting or surpassing supercomputers for specific operations in a highly affordable fashion. Such application specific processor technology may be modular and packaged within racks with other avionics hardware.

PHASE I: Provide a feasibility study which analyzes technology and specific needs of real time perspective scene generation and defines an approach to processing such imagery. Particular attention should be given to working with various military sensors including both on-board and off-board sources of imagery. Wherever feasible solutions should include either commercial or Navy owned software (i.e. PowerScene), preferably written using existing or projected commercial standard graphics language, and appropriate visualization media. The approach to demonstrating a specific demonstration in a Phase II SBIR effort shall be defined.

PHASE II: Develop, test and operationally demonstrate the ultra high speed image processor defined during the Phase I SBIR effort. Study and define self test and maintenance concepts.

PHASE III: Produce the modular ultra high speed processor system demonstrated in the Phase II effort. This will include transition to other Navy programs in airborne situational awareness.

COMMERCIAL POTENTIAL: Application specific ultra high speed processor technology should have payoff in numerous commercial applications such as remote real time surgery, robotics, news media, and others.

REFERENCES:
1. IEEE Graphics Language Standards, MIL-E-5400 Class II

N95-128 TITLE: Adaptive Beamforming for Mutistatic Active Sonar

OBJECTIVE: Develop a set of mathematical algorithms to efficiently implement a beamformer for multistatic sonar systems that can automatically adapt to a highly variant noise field.

DESCRIPTION: A set of mathematical algorithms is required to adaptively form beams from sonar arrays used as the receivers in multistatic active fields. Optimum suppression of ship radiated noise and scattering from topographical features is required to obtain maximum effective array gain. Sound sources will be both impulsive broadband as well as both narrow and broadband coherent. Maximum algorithm efficiency in terms of processing requirements is desired to minimize processing resources to allow for potential implementation in expendable sensors.

PHASE I: Study and develop adaptive beamforming algorithms for active multistatic applications that automatically suppress directional interference sources with little or no degradation of signals. Examine real data on successive range bins and mathematically determine algorithm effectiveness in improving echo to noise ratios while suppressing false alarms.

PHASE II: Design and implement on a commercial system an active multistatic adaptive beamformer.

PHASE III: The Navy may implement an efficient adaptive beamformer in all air ASW aircraft as well as in expendable sensors.

COMMERCIAL POTENTIAL: Efficient algorithms developed under this SBIR may offer breakthroughs in diagnostic acoustics in the medical field, seismic surveys, and other acoustic diagnostics throughout industry.

N95-129 TITLE: Expendable Small Object Avoidance (SOA) Sonar Detector

OBJECTIVE: Determine if technology can be adapted or developed to make a low cost expendable sonar practical for the detection of mini-submarines, bottomed submarines and mines.

DESCRIPTION: Systems are in development using electro-optic (E-O) techniques for the detection of small objects in shallow littoral waters. A complementary expendable acoustic system would be beneficial to these systems for reduction of false alarms and to overcome the deleterious effects of turbidity. The problem to be solved is the tradeoff of materials and technologies necessary to achieve an air dropable acoustic system that can be built at low unit cost and can be packaged in a form factor no larger than a right circular cylinder 4.75" in diameter and 36" in length.

PHASE I: (1.) Conduct a tradeoff study to determine the technical parameters necessary in an expendable sensor to complement existing and planned helicopter employed E-O systems for the detection of small underwater objects. Measures of effectiveness shall include the helicopter search rate and false alarm rate, with and without the proposed expendable active acoustic sensor.

(2.) Conduct a technology search study to determine the critical technologies that need to be developed to meet the technical parameters determined in (1.) above. Include in this study the required sensor and field processing to achieve optimum tactical performance.

(3.) Perform a unit cost study as a function of yearly purchase quantities and performance parameters.

PHASE II: Design and manufacture a prototype low cost expendable sonar in an "A" size (Diam: 4.75", Length: 36") package that will effectively complement existing helicopter E-O systems.

PHASE III: Navy procurement of a low cost expendable that will improve the fleet's ability to avoid mini submarines, bottomed submarines and mine fields. Transition will be accomplished with a sonobuoy development program with either Advanced Development or Engineering Development funds, depending on remaining technical risks after the completion of PHASE II.

COMMERCIAL POTENTIAL: High-energy acoustic ceramics and batteries required to meet this requirement have numerous applications in high frequency acoustic applications in the medical field and throughout industry in materials and structural test. Tracking marine animals and survey of underwater objects are other potential commercial applications.

N95-130 TITLE: Fault-Tolerant Navy Tactical Data Processing

OBJECTIVE: Use scalable, fault-tolerant computing systems/modules in handling Navy tactical data to ensure fail-safe operation without compromising performance/mission safety. Organic (embedded) computers play a significant role in controlling critical

military and civilian functions. The increasing complexity in modern military and industrial equipment increases the probability of malfunctions or mission failures. Failure in any of these computers can be catastrophic, particularly, when the environment becomes hostile due to an act of nature or war. Use of multiple fault tolerant computing systems is a way of ensuring/minimizing fail-safe operation without compromising mission safety. These proposed systems will allow redundancy to be designed throughout the next generation of platforms. The scalability of these systems permit configuration selection based on the number of likely faults within the Mean-Time-To-Repair to ensure continuous fail safe operation.

DESCRIPTION: Develop an innovative, "dual use", multiple fault tolerant, VMEbus and Futurebus+-based computer systems capable of executing real-time Ada/Ada 9X code. VMEbus and Futurebus+have been chosen because of their world-wide usage in military and commercial applications.. The proposal should use a high performance and ultra-reliable RISC computing engine (ex., Intel i960 RISC processor because of its usage in newer systems (F-22, among others)), designed with redundant parts and special fault handling capability, that continues working in-spite of several component failures. These computers (Intel i960 RISC VMEbus and Futurebus+) will be scalable, i.e. users can select application specific configurations for the degree of fault tolerance required, making it efficient and inexpensive. It also permits fault tolerance to be extended outside the computing platform, providing the opportunity, to make the entire application fault tolerant. The approach will be to add fault tolerance to existing technology rather than design it from scratch.

PHASE I: Define the prototype tactical data system. Define the technical performance/reliability requirements the fault tolerant system modules must meet. Define the system tactical interfaces (1397, 188-C, 1553B, etc.) data input/output requirements.

PHASE II: Develop, test and prototype tactical data interface modules, perform design verification and testing for manufacturability/producibility based on definitions/requirements of Phase I. Begin development of commercial market

PHASE III: Develop, test and integrate modules developed under Phase II into tactical data system. Conduct system integration testing. Transition to commercial production. Deliver to Fleet.

COMMERCIAL POTENTIAL: Civilian equipment, driven by intelligent computing engines, requiring a high degree of on-line performance, can benefit from these systems such as: Emergency life support, Power Plant and electrical distribution systems, On-line transaction processing, Traffic control equipment (air traffic control, MagLev Trains, subway systems), Future national computer networks and databases

REFERENCES:

1. MIL-STD-1397
2. MIL-STD-1553(B)
3. MIL-STD-188C
4. MIL-STD-SDD

N95-131 TITLE: <u>Digital Voice Signal Distribution for Crew Communication</u>

OBJECTIVE: Improve aircraft communications by implementing an interphone communications capability having digital signal interfaces with microphones, earphones, and radios.

DESCRIPTION: Current interphone communication systems either distribute analog voice communications, or provide digital interphone signal routing with digital to analog (or analog to digital) conversion of voice signals prior to interface with analog microphones or earphones. The effort identified here, is to describe a hardware and software approach to a completely digital signal routing and control capability enabling digital voice information to come directly from microphones or to be provided directly to earphones, and which uses direct digital interface with radios.

PHASE I: Provide a feasibility study which develops a method to provide total digital voice signal distribution of interphone communications through to the crew member's headset. This process will concentrate on defining the signal conversion at the microphone and earphone, and the interphone signal distribution and control implementation. The signal distribution will utilize digitized audio compatible with the wideband audio input and output of receiver/transmitters such as the AN/ARC-182 and AN/ARC-210. The bus structure for signal interconnectivity is to use fiber optics. The interphone communication units shall be modular and of minimum weight, size, and cost with applicability to such aircraft as the E-2C, P-3C, CH-53, and CH-46E. The feasibility of an embedded approach using software to control the interface with other multifunction controls and displays will also be evaluated. Coordination of this work will be established with appropriate aircraft and crew systems PMAs.

PHASE II: Develop, fabricate, test, and operationally demonstrate the digital voice signal distribution functions

formulated for interphone communications during the Phase I SBIR effort.

PHASE III: Produce components of the digital voice signal distribution system, thereby providing system availability and enabling transition onto multi-crew station aircraft.

COMMERCIAL POTENTIAL: This process of total digital intercommunications is an expansion of current trends for digital signal processing of communications to improve signal reception and transmission. Additionally, this process offers potential for embedding interphone communication system (ICS) control functions for software implementation. It will have its greatest potential on aircraft with multiple crew stations.

REFERENCES:

1. MIL-R-29583 (AS) Radio Set, AN/ARC-210(V)
2. MIL-R-85664 (AS) Radio Set, AN/ARC-182(V)

N95-132 TITLE: Corrosion Preventive Compounds or Preservative with Lower Volatile Organic Compound Content

OBJECTIVE: Develop corrosion preventive compounds (CPC) or preservatives with water displacing characteristics using the state-of-the-art technology to meet current environmental laws/regulations and the performance requirements of MIL-C-81309, MIL-C-85054, MIL-C-6529, MIL-C-16173, MIL-C-11796, MIL-L-63460, or for a specialized application.

DESCRIPTION: Some current state and local environmental laws/regulations restrict the use of CPC or preservatives and the National Emissions Standard for Hazardous Air Pollutants will have limitations for CPC or preservatives in 1997. CPC or preservative is used in various applications for aircraft structure, avionics/equipment and engines. The NAVAIR 01-1A-509 Aircraft Weapons Systems Cleaning and Corrosion Prevention/Control manual, the NAVAIR 16-1-540 Avionics Cleaning and Corrosion Prevention/Control manual, and the NAVAIR 17-1-125 Support Equipment and Corrosion Control manual contain CPC or preservative applications.

PHASE I: Develop new CPC formulation(s) with water displacing characteristics that meet current environmental laws/regulations and the performance requirements for its target application(s). Identify new formulations and potential applications. Conduct preliminary laboratory testing to demonstrate the feasibility of the CPC or preservative formulation for its target applications.

PHASE II: Further develop new CPC formulation(s) based on phase I results. Conduct preliminary laboratory testing and field testing. Also, conduct comparison testing with the CPC being substituted. The above comparison testing shall demonstrate that the new CPCs meet all the performance requirements and the environmental laws/regulations for the target application(s). If necessary, propose amendments to existing military specifications or propose new military specifications for these CPCs to cover their technology.

PHASE III: Produce the CPC formulation(s) demonstrated in the phase II effort for both the military and commercial market.

COMMERCIAL POTENTIAL: New CPCs can be used on commercial aircraft as well as non aerospace applications for both government and private sector.

REFERENCES:

1. MIL-C-81309
2. MIL-C-85054
3. MIL-C-6529
4. MIL-C-16173
5. NAVAIR 01-1A-509

N95-133 TITLE: Integrated Product Data Environment

OBJECTIVE: Reduce weapon system support cycle time and associated costs through the use of an Integrated Product Data Environment (IPDE) in manufacturing and rework facilities.

DESCRIPTION: Currently the aviation engineering and manufacturing activities utilize a combination of paper and digital product data for the design, manufacture or rework of a system, equipment, or component. This data is stored within functional

areas and is not readily accessible between functional areas. The vision of an IPDE is for all or parts of a single activity and its suppliers to be able to work from a common digital data base, in real time, on the design, development, manufacturing, distribution, and servicing of a weapon system, equipment, or component. The direct benefits would come through substantial reductions in cycle time and costs, along with significant enhancements in quality and performance.

PHASE I: Provide a concept study that integrates: product data to provide a consistent view of all product information across the enterprise; an information highway to provide access to the integrated product data; the interconnection of work processes throughout the enterprise; and reengineered business processes that take maximum advantage of integrated product data and product data tools for workers to efficiently and effectively support a weapon system.

PHASE II: Develop and test a prototype IPDE, formulated under the Phase I SBIR effort, at a NAVAIR rework facility to demonstrate and document its feasibility and benefits. Based on the prototype provide a technical architecture that will allow for IPDE implementation.

PHASE III: Implement the IPDE, documented in the Phase II SBIR effort, throughout the NAVAIR rework/manufacturing facilities.

COMMERCIAL POTENTIAL: The developed product would give industry a structure that will allow for radical improvement in the management of product data. The direct benefits to industry would be a substantial reduction in product development cycle time and costs, along with significant enhancements in product quality and performance.

REFERENCES:

1. MIL-STD-1840
2. MIL-D-28000 & 28003, STEP

N95-134 TITLE: Recycling of Cured Composite

OBJECTIVE: To develop a process to recycle cured composite materials and to develop uses for the recycled product.

DESCRIPTION: The navy currently uses composite materials in aircraft structure due to the high strength, environmental resistance and light weight. Unlike metals composites can not be easily reprocessed into new parts due to the chemical changes that occur during processing. Composite material contain high value fibers that can provide improved properties to a number of marketable products in DoD and the commercial sector. This effort will develop methods to utilize the superior properties of the high strength fibers found in cured composite material in a marketable product. Recycling will reduce the amount of composite in landfills, provide a means to dispose of retired composite structures and provide a payback to the processor to offset the cost of recycling.

PHASE I: Evaluate state of the art processes to reduce composite structures into useful forms that may be used as reinforcement, fillers and additives to commercial products. These processes should include mechanical, chemical and thermal methods to recycle cured structures. Potential uses of the recycled materials should also be identified along with market size, product form requirements and cost.

PHASE II: In this phase the most promising reduction method will be scaled up and used to produce sample quantities of material which will be used to fabricate a marketable product. The cost of recycling the composite, fabrication of the marketable product and the performance of the product will be evaluated.

PHASE III: In this phase a full scale recycling facility will be set up to reduce cured composite material to a useful product form. This facility may be stand alone or in conjunction with the facilities of the secondary product fabricator.

COMMERCIAL POTENTIAL: The use of composite materials in the construction and transportation industries will provide both a source of composite materials and a potential for secondary uses.

N95-135 TITLE: Adhesive Bond Integrity of Composites

OBJECTIVE: To clearly define nondestructive inspection (NDI) methods using state-of-the-art technology to determine adhesive bond strength integrity quantitatively vice qualitatively.

DESCRIPTION: With the continuing rapid improvements in advanced composite materials technology, adhesive bonding integrity is always a matter of concern. In particular, this concern applies to commercial aerospace applications as well as high performance military aircraft. Adhesive bond integrity affects commercial and military aircraft application since employment

of advanced composite materials are being expanded as a means to reduce weight and corrosion.

PHASE I: Perform search of commercially available NDI equipment and potential modifications or develop new equipment to meet the objective. Conduct preliminary laboratory testing to demonstrate the feasibility of the potential NDI method. Also, as a means of screening for potential NDI techniques for determination of adhesive bond integrity.

PHASE II: Development of NDI methods and testing of prototype inspection equipment as determined from Phase I feasibility studies. The design development and testing of prototype NDI equipment shall be accomplished. Additionally, the prototype inspection unit shall be a deliverable.

PHASE III: Commercialize NDI equipment and inspection methodology.

COMMERCIAL POTENTIAL: Extensive commercial and military industrial applications.

N95-136 TITLE: Ultrahigh Fidelity Inspection of Advance Composite Materials

OBJECTIVE: To clearly define nondestructive inspection (ND) methods using state-of-the-art technology to determine the orientation of laps, gaps, and ply layer of occurrence in advanced composite materials.

DESCRIPTION: New designs and manufacturing processes are rapidly improving the strength and fatigue characteristics of many advanced composite materials. The performance of many of these new composite materials is highly sensitive to ply orientation, lap and gap thicknesses, fiber waviness, etc. There is a critical need in both the commercial and military aircraft industries for NDI techniques which are capable of quantifying variations in ply orientation, etc. Ultrahigh fidelity inspection of advanced composite materials requires additional research in defining tape imperfections, proper fiber placement, orientation of laps and gaps, and through thickness ply location. The increased sophistication of advance composite materials being considered for use on commercial and military aircraft as a means to reduce weight and maintenance costs requires improved inspection methods to assure material integrity.

PHASE I: Perform literature search of ND methodology and of commercially available ND equipment as a means of screening for potential ND techniques and methods for determination of advanced composite materials integrity. Conduct preliminary laboratory testing to demonstrate the feasibility of the potential ND technique(s) and method(s).

PHASE II: Development of ND method and/or prototype inspection equipment as determined from Phase I feasibility studies. The design development and testing of prototype ND equipment shall be accomplished. Additionally, the prototype inspection unit shall be a deliverable.

PHASE III: Commercialize ND equipment and military industrial applications.

COMMERCIAL POTENTIAL: Current potential for use of this technique/equipment exists in the commercial and private aerospace industry and a future potential for the automotive industry as more advanced composite materials are utilized.

N95-137 TITLE: Wearable Electronics for Man Machine Interface

OBJECTIVE: Increase the functionality and productivity of the human operator while decreasing the life cycle cost of associated electronics.

DESCRIPTION: The Navy currently uses non-portable computers and equipment for most applications which involve interfacing with an operator. Digital electronics technology has been progressing at a rate which doubles about every two years and is expected to do so for the remainder of the decade according to the semiconductor industry association. Emphasis in commercial digital and analog electronics has changed direction from relatively stationary electronics to man portable electronics and is expected to migrate to wearable electronics in the near future. Wearable electronics potentially could increase the efficiency and productivity of personnel in training, conducting maintenance, rehearsing missions, operating equipment, etc. Future hardware may enhance performance of military systems operations without building expensive and rapidly changing electronics into the platform itself.

PHASE I: Provide a feasibility study which analyzes technology, industry projections and compares such to the needs of the Navy to perform training, maintenance, rehearsal, and military operations in a carrier based aviation environment. Particular attention should be given to the at sea operational environment and, if necessary, applications should distinguish between land and sea based operations. Near to far term applications of wearable systems shall be identified and reported along with an approach to demonstrating high payoff applications in a Phase II program including power source, electronics and human interface hardware (e.g., displays, earphones, voice recognition, etc.)

PHASE II: Develop, test and operationally demonstrate various wearable subsystems identified during the Phase I SBIR effort. Study and project any special maintenance, safety, or operational requirements for such wearable systems.

PHASE III: Produce the wearable electronics subsystems and systems demonstrated in the Phase II effort. This will include transition to other Navy programs such as training, mission planning, maintenance, operational systems, etc.

COMMERCIAL POTENTIAL: Wearable electronics could find numerous commercial applications in training equipment operators, performing maintenance, rehearsing scripts, and enhancing operations.

REFERENCES:
1. MIL-E-5400 Class 2
2. MIL-E-16400 Class 2

N95-138 TITLE: Realistic Correlated Infrared Sensor Scene Generation

OBJECTIVE: To improve the correlation of simulated Infrared Sensor (IR) scenes with out-the-window scenes synthesized from digital terrain elevation data and satellite imagery and/or aerial photography, thereby enhancing mission planning, mission preview, mission rehearsal, and training activities.

DESCRIPTION: Visual simulation systems capable of generating synthesized dynamic perspective views of the terrain from actual satellite imagery and/or aerial photography with digital terrain elevation data have the potential to enhance greatly the effectiveness of mission planning, mission preview, mission rehearsal, and training activities. Currently lacking, however, are correlated views of the terrain for sensors, such as Infrared (IR), with the same high degree of realism and fidelity as the visible spectrum scenes. This effort will develop innovative techniques for deriving high- fidelity IR scenes from the same data sources as are used to generate the visible spectrum scenes, specifically digital terrain elevation data and visible spectrum (400 to 700 nanometers) imagery.

PHASE I: Provide a feasibility study which develops one or more methods for specific sensor systems capable of deriving realistic, high-fidelity IR scenes from digital terrain elevation data and actual terrain imagery in the visible spectrum. The methods shall be highly automated, requiring virtually no human interaction, and shall be capable of implementation on relatively low-cost engineering workstations. Preprocessing of imagery and elevation data to derive intermediate data, such as terrain material classifications, shall be permitted, but techniques which require no such preprocessing shall be preferred.

PHASE II: Develop, test, and operationally demonstrate the IR scene synthesis techniques formulated under the Phase I SBIR effort.

PHASE III: Incorporate the methods demonstrated in the Phase II effort with existing and emerging Navy mission planning, mission preview, mission rehearsal, and training systems.

COMMERCIAL POTENTIAL: Improvements in the correlation of simulated IR with out-the-window scenes synthesized from digital terrain elevation data and satellite imagery and/or aerial photography has numerous commercial applications, among them an increased ability to portray remotely sensed scenes as well as advancing the state of the art in our ability to map and chart mineral deposits.

N95-139 TITLE: Realistic Correlated SAR Scene Generation

OBJECTIVE: To improve the correlation of simulated Synthetic Aperture Radar (SAR) scenes with out-the-window scenes synthesized from digital terrain elevation data and satellite imagery and/or aerial photography, thereby enhancing mission planning, mission preview, mission rehearsal, and training activities.

DESCRIPTION: Visual simulation systems capable of generating synthesized dynamic perspective views of the terrain from actual satellite imagery and/or aerial photography with digital terrain elevation data currently exist and have the potential to enhance greatly the effectiveness of mission planning, mission preview, mission rehearsal, and training activities. Currently lacking, however, are correlated views of the terrain for sensors, such as Synthetic Aperture Radar (SAR), with the same high degree of realism and fidelity as t visible spectrum scenes. This effort will develop innovative techniques for deriving high-fidelity SAR scenes from the same data sources as are used to generate the visible spectrum scenes, specifically digital terrain elevation data and visible spectrum (400 to 700 nanometers) imagery.

PHASE I: Provide a feasibility study which develops one or more methods for specific sensor systems capable of

deriving realistic, high-fidelity SAR scenes from digital terrain elevation data and actual terrain imagery in the visible spectrum. The methods shall be highly automated, requiring virtually no human interaction, and shall be capable of implementation on relatively low-cost engineering workstations. Preprocessing of imagery and elevation data to derive intermediate data, such as terrain material classifications, shall be permitted, but techniques which require no such preprocessing shall be preferred.

PHASE II: Develop, test, and operationally demonstrate the SAR scene synthesis techniques formulated under the Phase I SBIR effort.

PHASE III: Incorporate the methods demonstrated in the Phase II effort with extant and emerging Navy mission planning, mission preview, mission rehearsal, and training systems.

COMMERCIAL POTENTIAL: Improvements in the correlation of simulated SAR with out-the-window scenes synthesized from digital terrain elevation data and satellite imagery and/or aerial photography has numerous commercial applications, among them an increased ability to portray remotely sensed scenes as well as advancing the state of the art in our ability to map and chart mineral deposits.

N95-140 TITLE: Unmanned Aerial Vehicles (UAV) Imagery Processing for Geophysical Information System (GIS) Applications

OBJECTIVE: Investigate sensor suite and imagery processing workstation for Unmanned Aerial Vehicles (UAV) to be used in collecting geographic/geophysical data and build a low cost Geophysical Information System (GIS) for mission planning and targeting selection.

DESCRIPTION: Geophysical information systems(GISs) traditionally have been used by the Air Force in weapons avionics and mission planning in which expensive satellite data and long lead-time planning/data reduction effort are required to built a GIS for limited applications. A UAV with GPS aided autonomous navigation system can serve as a low cost sensor platform for collecting precise geographic images/conducting geophysical survey in near realtime; the envisioned UAV sensor may be 3-D imaging with stereoscopic staring sensor, laser range finder for precise distance measurement, or multispectral sensor for locating natural/artificial artifacts, etc.; the latest commercial computer workstation and off-the-shelf image processing/GIS software may be used to build a multidimensional and features laden map/database by the lower echelon commander for their operational area for near realtime mission planning and force maneuver and target selection.

PHASE I: Investigate the sensor suite enhancements for the UAV and identify an imagery processing workstation/software for UAV GIS applications. Perform requirements analysis, architecture definition, and conduct technology trades.

PHASE II: Develop prototype hardware/software, and demonstrate a low cost UAV Imagery Processing/GIS system.

PHASE III: Productize the UAV GIS sensor(s) and imagery processing/GIS workstation and conduct field test.

COMMERCIAL POTENTIAL: The UAV GIS system has potential applications for law enforcement, i.e., build a GIS database for correlation/analysis of crime patterns and trends, command and control/tactical decision aid database during emergency response; The UAV GIS system can also be used during Federal Emergency Management Agency (FEMA) emergency response coordination and disaster relief effort. Other commercial applications include building accurate geophysical survey/GISs of existing utility grids or gas pipelines or highways/bridges for periodic maintenance and emergency repairs, urban development area surveying/zone planning, agricultural resources/land utilization management, etc.

N95-141 TITLE: Effective Retrieval of Human Technical Knowledge

OBJECTIVE: Develop an effective method of obtaining information from individual expert technical personnel for use in subsequent training computer-based training courses.

DESCRIPTION: Computer Based Training (CBT) systems have been shown to promote high learning training effectiveness and cost effectiveness. The most essential ingredient in these systems is the specific technical knowledge which they are designed to transmit. However, it is very difficult to retrieve this data stored in the technicians brains and record it on a more permanent and adaptable storage medium. A concept for a Naval "Electronic Capture and Handling, Integrated Engineering Facts" system (*e-CHIEF*) shall be formulated, designed and implemented to provide an effective method of obtaining the knowledge from the individual and using it in multiple, broad-based CBT applications, using a phased approach.

PHASE I: Establish basic *e-CHIEF* functional requirements, and define the psychological, training and technological

methods to be used to satisfy those requirements. The primary product will be a system design specification for processes and tools to effectively transmit technical knowledge from practitioners to a computer data base.

PHASE II: Develop *e-CHIEF* processes and the human and computer-based tools to support it. These computer based tools (ie, "the system") will feature maximum open architecture, broad applicability, and easy adaptation for use in each specific knowledge specialty. The system will facilitate separating the raw knowledge into discrete areas of technology to enable the information to be used functionally, across multiple applicable learning programs. PHASE II will conclude with a demonstration of a database produced using the system in an actual "knowledge transmission session." The products of Phase II will consist of written documentation of the processes to be used in conducting information-gathering sessions, and the computer-based tools (software) designed to assist those processes.

PHASE III: Refine *e-CHIEF* system and transition it into the mainstream. Here, the documentation of the processes and the design of the software tools will be finalized. Products include the processes and software tools as well as the initial *e-CHIEF* data base of recorded technical information.

COMMERCIAL POTENTIAL: Full application to business and academia training programs.

N95-142 TITLE: Low Cost Image Generator for Mission Rehearsal

OBJECTIVE: Investigate affordable high performance computational elements to develop real-time photo-texture based image generators (IG) for mission rehearsal.

DESCRIPTION: With the increased emphasis on synthetic environments Military and commercial trainer systems of the future will require affordable texture based Image Generator's. Requirements exist in areas such as mission rehearsal, mission planning and mission preview to utilize Photo-textured scene's as the primary planning tool. There are several companies developing boards for systems that are ADVERTISED to provide texture-based, image generator's at 30HZ. These boards (1 or more) in a system will cause a large cost reduction for operational mission rehearsal systems. Potential cost reduction for a system is 50 to 80 % of a current systems hardware cost.

PHASE I: Provide a report describing the proposed concept and a system implementation of an affordable photo based image generator.

PHASE II: Demonstrate a prototype image generator running photo-based images on a CRT and Helmet Mounted Display (HMD).

PHASE III: Transition the high performance Image Generator to a military mission rehearsal simulation system.

COMMERCIAL POTENTIAL: An expanding commercial use of image generators into the home game market, travel market and aircraft flight simulator market is expected. Commercial trainer applications into automobile simulators, train simulators, fire fighting simulators (virtual reality market) all expand as photo texture based system arrive.

N95-143 TITLE: Cordless Visual Display Technology for Virtual Environment Applications

OBJECTIVE: Develop digital hardware technology to produce a cordless, high resolution, lightweight, full color, head-coupled display for use in virtual environment applications.

DESCRIPTION: The dominance of the visual channel in human perception indicates the importance of head-mounted display technology to virtual environment research. Applications such as naval simulation and training are limited in their capabilities by display technology. Although the fidelity of display technology has been increasing regularly, an effort has not been made to eliminate the cords thus freeing the wearer of a connection to external equipment. Therefore, the technology development called for includes the elimination of all cords to the display as well as general display improvements. There are three primary technologies presently in use for stereoscopic displays in virtual environment research. For applications in which the operator cannot wear a physical device, a flat-screen stereoscopic display is used. A recent alternatives been to mount the display on a counter-balanced arm allowing the display to be heavier than a typical head-mounted display (Bolas, et al., 1994). In both boom-mounted and head-mounted displays, the display itself has been either LCD or CRT based. Technologies for cordless devices include infrared sensors and optoelectronics (Ward, et al., 1992). Current needs and requirements call for a cordless, high resolution(minimum of 1000 lines of resolution) display which is lightweight, full color, with a high field of view (greater than 100 degrees). The display should also be reconfigurable as view replacing (opaque) or view augmenting (transparent). Head-mounted displays are physically coupled to the head and an external tracking system to follow head movements. Therefore, in

compliance with the cordless requirement, a proposed solution must provide for integration with the signal generated from a cordless tracking device.

PHASE I: Provide a thorough investigation of current solutions and develop a design which addresses the needs and requirements listed above. A report describing the proposed solution, its technical improvements over past solutions, and its expected performance specifications will be required.

PHASE II: Develop, test, and demonstrate the solution described under the Phase I effort.

PHASE III: Produce the system developed under the Phase II effort for general purpose applications.

COMMERCIAL POTENTIAL: High resolution, high field of view, stereoscopic display technology is applicable to all forms of virtual environment research. The cordless improvement will enable a wider range of applications to be pursued which have been excluded to this point by technology constraints. The integration of cordless displays with cordless tracking facilitates applications such as firefighter training which are currently hampered by the state of the technology.

REFERENCES:
1. Bolas, MT., I.E. McDonnell, and. Mead. (1994). "Design Background for BOOM Viewers - A Family of Application Specific Head-Coupled Displays." Proceedings of SIP 1994 Conference 2177B - The Engineering Reality of Virtual Reality.
2. Ward, M., Azuma, R., Bennett, R., Gottschalk, S., & Fuchs, H (1992). A Demonstrated Optimcal Tracker With Scalable Work Area for Head-Mounted Display Systems. Proceedings of the ACM 1992 Symposium on Interactive 3D Graphics.

N95-144 TITLE: Six Degree of Freedom Tracking Devices for Virtual Environment Applications

OBJECTIVE: Develop digital hardware and software technology to enable cordless, long range, high fidelity six degree-of-freedom tracking in virtual spaces by human operators.

DESCRIPTION: Six degree of freedom tracking devices are a critical component of virtual environment systems in that they allow direct manipulation interaction between the human operator and virtual objects within the space. Virtual environment training problems, such as firefighter training require a large operating radius and low interference without the use of cords. In addition, virtual environment simulation problems, such as electronic warfare systems evaluation require high accuracy and sampling rates. The most common method currently in use is magnetic tracking which tracks the position and orientation of a receiver within a magnetic field. This can also be achieved through mechanical tracking which determines position and orientation through the relative positions of the joints in a mechanical arm. Other techniques include ultrasonic tracking, inertial tracking, and optical tracking (Ward, et al., 1992). Current needs and requirements call for a cordless system with a long range of operation (minimum ten foot radius). It must be lightweight, accurate, and insensitive to metallic interference enabling possible future shipboard use. Lastly, the device must have a low latency providing a high sampling rate. A proposed solution complying with the cordless requirement must provide for integration with a video signal as would be used in a head-mounted display.

PHASE I: Provide a thorough investigation of current solutions and develop a design which addresses the needs and requirements listed above. A report describing the proposed solution, its technical improvements over past solutions, and its expected performance specifications will be required.

PHASE II: Develop, test, and demonstrate the solution described under the Phase I effort.

PHASE III: Produce the system developed under the Phase II effort for general purpose applications.

COMMERCIAL POTENTIAL: A six degree of freedom tracking system as described would be applicable to all virtual environment applications including those in the medical field as well as scientific visualization. The aforementioned firefighter training example extends beyond military use into all types of firefighter training.

REFERENCES:
1. Ward, M., Azuma, R., Bennett, R., Gottschalk, S., & Fuchs, H. (1992). A Demonstrated Optical Tracker With Scalable Work Area for Head-Mounted Display Systems. Proceedings of ACM 1992 Symposium on Interactive 3D Graphics.

N95-145 TITLE: Thermal Stability Enhancing Additive for JP-5 Fuel

OBJECTIVE: Development of an additive that will increase the stability of JP-5 fuel at elevated temperatures without deteriorating the performance of the fuel.

DESCRIPTION: Future generations of gas turbine engines for naval aircraft and missile application have strong requirements for high specific thrust ratios and low specific fuel consumption. In order to meet these goals, gas turbine engines must operate at significantly higher temperatures and pressures. Currently used JP-5 fuel (narrow cut kerosene jet fuel) will oxidize prematurely at the elevated temperatures anticipated in the new turbine engines. Additive technology exists that will extend the elevated temperature stability of jet fuel but does not stabilize the fuel at the very high inlet temperatures expected. Also, such technology deteriorates other performance properties of the fuel such as water-shedding ability, low temperature characteristics, filterability, and ignition quality.

An innovative additive development effort is required to address the problem of premature oxidation of the fuel due to the high temperatures expected in future generation gas turbine engines. The additive must be compatible with JP-5 fuel in that it does not degrade the important properties of the fuel. In addition, contaminant pickup from shipboard CuNi aviation fuel systems has been shown to degrade the thermal stability of JP-5 and must be addressed in the development.

PHASE I: Efforts should demonstrate the stability enhancing chemistry necessary for high temperature JP-5 performance.

PHASE II: Covers the formulation of doped JP-5 fuel and demonstration of high temperature stability improvement over undoped fuel.

PHASE III: The contractor will scale up the production of the additive formulation in PHASE III for marketing to fuel suppliers as a NAVAIR-approved additive package for JP-5.

COMMERCIAL POTENTIAL: The new additive technology will be applicable to all kerosene based fuels for enhancing both thermal stability and storage stability. Commercial gas turbines will operate at higher temperatures also.

N95-146 TITLE: Energy Dissipation Characterization and Design Methodology for Composite Materials

OBJECTIVE: To develop energy dissipation characterization methodologies for composite material/laminate characterization and design of aircraft certification representative structure.

DESCRIPTION: Energy Dissipation approaches to composite material characterization and design offer the potential to significantly reduce the cost and schedule associated with composite materials for advanced Navy platforms. This technology utilizes energy methods to characterize composite material/laminate energy dissipation under multi-axial loading conditions, better representing actual composite material structural response in both the linear and non-linear regions. The extensive data generated by this approach provides improved material/laminate characterization for use in finite element modeling and design of composite structure. This program will assess current composite material characterization methodologies and evaluate/develop proposed methodologies for use in composite materials and structural development.

PHASE I: Evaluate energy dissipation methods compared with currently accepted composite material/laminate characterization and design methodologies. Develop an approach for certification methodology development and perform an analysis of benefits when fully implemented.

PHASE II: Develop and demonstrate the analytical certification methodologies which support the application of this technology for advanced air vehicles. Validate the attributes of the technology in terms of performance, cost and schedule.

PHASE III: Apply this technology for certification of representative demonstration components.

COMMERCIAL POTENTIAL: This technology will be able to be put into practice on commercial aircraft and will provide an avenue for continuing the U.S. lead in advanced composites.

REFERENCES:

1. P.W. Mast, J.G. Michopoulos, L.W. Gauss and R. Badaliance, "Dissipated Energy Density Characterization of Composites", NRL.

2. P.W. Mast, G.E. Nash, J. Michopoulos, R.W. Thomas, R. Badaliance and I. Wolock, "Experimental Determination of Dissipated Energy Density as a Measure of Strain-induced Damage in Composites", NRL/FR/6383-92-9369, April 17, 1992. ADA250322

N95-147 TITLE: Water Crash Dynamics and Structural Concepts for Naval Helicopters

OBJECTIVE: Determine the hydrodynamic response characteristics of Naval helicopters during sudden water penetration associated with crashes at sea. Based on the determination of impact pressure and force distribution time histories on typical

hull shapes, develop potential structural concepts and associated requirements necessary to be used as a design tool for achieving water impact survivability. Crash deceleration time history data required for on-board crash sensor calibration and energy absorbing seating will also be defined.

DESCRIPTION: The Navy operates a fleet of approximately 1500 helicopters, all of which include substantial over-water missions. Nearly 90% of crashes for some Navy helicopter types occur into water. Though ground and barrier impact characteristics are very well understood through U.S. Army and automotive research, extremely little is known about water crash dynamics. As a result, no crash criteria (other than low severity ditching) or design approaches exist for the Navy, or civil, water impact threat. This effort will use pre-existing computer simulation codes to predict water impact response properties of typical helicopter hulls suddenly penetrating into water. After validating predictions, this information will then be used to determine crashworthiness subsystem requirements and potential structural concepts for providing survivability under water crash conditions.

PHASE I: Use currently available computer simulation programs, such as KRASH and/or CFD codes, to predict water impact response properties of typical helicopter hull shapes penetrating into water throughout a range of typical impact conditions. Determine pressure and force distribution time histories, as well as vehicle kinematic response. Develop a preferred developmental approach and determine the technical merit and feasibility of this approach. Evaluate the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector.

PHASE II: Design/manufacture prototypes and validate computer predictions through scale model and sectional drop testing into water. Obtain measured pressure and force levels, as well as kinematic responses, to compare predicted and actual results. Based on validated results, determine deceleration time histories required for calibration of onboard subsystems such as crash sensors and energy-absorbing seats. The end product of Phase II will be a determination of structural requirements to be used as a design tool for managing water impact forces in future Naval helicopters.

PHASE III: Apply the results of the SBIR effort to crashworthy products intended for use by the U.S. Government and the private sector. The Federal Aviation Administration (FAA) will be able to establish water impact criteria for civil helicopters as a result of this effort.

COMMERCIAL POTENTIAL: In addition to helicopters, the results of this effort can be applied as a base for other applications including lightweight aircraft.

REFERENCES:
1. MIL-STD-1290 & Aircraft Crash Survival Design Guide (USAAVSCOM TR 89-D-22A)

N95-148 TITLE: In-Situ Advanced Fiber Placement and Processing

OBJECTIVE: To develop, optimize and implement advanced fiber placement using in-situ consolidation for composite structures. Demonstrate the certifiability of the technology, develop a repeatable process and characterize the advantages of the process for composite material applications. Develop and demonstrate an advanced in-situ fiber placement head design which can be scaled-up to full scale aircraft fiber placement applications

DESCRIPTION: In-situ fiber placement is the next logical step in advanced fiber placement technology applicable to staging thermoset materials and consolidating thermoplastic or thermoplastic/thermoset hybrid composites. This innovative technology provides the promise to automate the composite lay-up and consolidation process to eliminate/minimize post-processing via autoclave. Also, this process provides significant opportunity for unitizing composite structures via fiber placement over substructure w/o adhesive bonding.

PHASE I: Develop and evaluate innovative approaches to advanced in-situ fiber placement heat application/control and consolidation. Develop proposed concepts and design approaches for fiber placement head design to produce repeatable, cost effective certification representative aircraft and missile composite structure.

PHASE II: Design and build an optimized in-situ fiber placement head for subscale demonstration. Demonstrate process performance and characterize process parameters for applicability to primary composite structure. Evaluate the critical aspects of the materials processed using this innovative approach and recommend process/material enhancements for further development and scale-up.

PHASE III: Demonstrate the reproducibility of the process and evaluate the structural performance of a prototype system addressing critical Navy concerns.

COMMERCIAL POTENTIAL: Significant potential to change the paradigm of the composite manufacturing process.

REFERENCES:
1. Advanced Research Projects Agency
2. Great Lakes Composites Consortium

N95-149 TITLE: Advanced Induction Welding of Composites with Out-of-Plane Reinforcement

OBJECTIVE: Develop concepts for improved primary structural bond strengths using advanced induction welding and joining of composites via out-of-plane reinforcements. Demonstrate the performance of inductively welded composites with out-of-plane reinforcement for use in certification representative structure. Analyze the cost, weight and performance benefits when applied to Navy aircraft.

DESCRIPTION: Induction welding of advanced composites offers the potential to significantly reduce the cost and weight of advanced Navy aircraft and missile systems. This technology, through the minimization or elimination of fasteners offers payoffs such as weight, cost, aerodynamics, observables, fuel sealing, lightening strike etc. The basic induction welding technology utilizes susceptor screens in the bondlines to locally heat thermoplastic films which melt fuse to the substrates to be joined. Incorporation of out-of-plane reinforcements in this bondline could provide significant improvements in joint strength, minimizing the requirements for a large joint surface area in structural applications. This technology shows significant promise in terms of enhanced bond strength over conventional approaches. The incorporation of reinforcements out-of-plane offers the potential for significant improvements over the current state-of-the-art. This program will provide the foundation for truly unitized composite structure.

PHASE I: Develop advanced joining technology for composite primary structures minimizing the need for fasteners through reliable, certifiable joints. Innovative approaches to improve bond strengths as feasible alternatives to current bolted structure will be evaluated. Demonstrate concept feasibility to substantiate phase II process development and demonstration for representative application.

PHASE II: Demonstrate subscale applications of preferred approaches and develop analysis and certification methodologies as well as assess benefits for aircraft structure.

PHASE III: Implement and validate the technology on advanced demonstration articles representative of production hardware.

COMMERCIAL POTENTIAL: Significant payoff for commercial aircraft as well as non aerospace applications.

N95-150 TITLE: Composite Material Design and Manufacturing Assessment for Advanced Navy Aircraft and Missile Systems

OBJECTIVE: To identify the cost and performance trade-offs associated with the introduction of improved composite materials systems and manufacturing methods in aerospace structures.

DESCRIPTION: Historically, the development trend in the advanced composites community has been towards stronger, stiffer, tougher materials. These trends have been realized through the introduction of new high performance fibers, and toughened matrix systems. However, increased emphasis on low-cost weapons systems requires cost/performance trade-offs associated with these various composite materials and manufacturing methods be identified in advance of production.

PHASE I: Identify advanced airframe structural composite components and their cost and performance drivers. Identify candidate materials systems representative of various levels of maturity, performance, and cost. Perform preliminary cost/performance trade-offs associated with candidate materials systems, candidate manufacturing methods, and candidate structures. Develop a concept for a model to evaluate material performance/cost/selection trades.

PHASE II: Expanded Phase I activities to include alternate manufacturing approaches and complexity of structural application. Develop a model for cost/performance modeling of composite materials, processes, and structures.

PHASE III: Cost/performance model implementation for commercial aviation and infrastructure.

COMMERCIAL POTENTIAL: Cost/performance models are of interest to those seeking to develop and apply advanced composite materials in commercial and industrial markets where cost is a much greater driver than performance.

N95-151 TITLE: Test and Evaluation Tool for Calibration and Dynamic Testing of Manikin Systems

OBJECTIVE: Current calibration methods of manikin systems primarily consists of static measurements. The manikin system, however, is utilized to evaluate dynamic loads. The objective of this research topic is to develop a test fixture to facilitate short duration, dynamic testing and systems-level calibrations of an anthropomorphic manikin vertebral column/head complex. This dynamic calibration capability is essential for repeatability of test results from one test series to the next, and is particularly important for accurate and fair evaluation of life support systems.

DESCRIPTION: During the initial stages of an ejection, an aviator can be exposed to injurious levels of acceleration along his or her spinal column. Accordingly, fractures of the lower thoracic and upper lumbar vertebrae have been recognized as one of the most dominant major injuries which occur during ejections. Over the years, advanced anthropomorphic test devices have been used to estimate the potential for spinal injury. Typically, prior to testing, these devices are assembled from an inventory of pre calibrated components. The development of a calibration fixture to evaluate the systems-level biofidelic performance is desirable to improve the predictive consistency of the device. The fixture must be capable of providing accurate and repeatable excitations sufficient to produce reliable calibrations. Additionally, the fixture must possess the versatility to conduct short duration, dynamic studies of aircrew interaction with various seating and restraint systems.

PHASE I: A feasibility study shall be conducted which details the conceptual design, analysis, and proof of concept.

PHASE II: A fully functional prototype test/calibration fixture shall be developed which fulfills the Phase I objectives. Refine the prototype hardware and deliver preproduction units.

PHASE III: The developer shall implement the capabilities and technologies learned for the specific Navy use and transfer this technology for use by other DOD and government agencies including the U.S. Air Force and Department of Transportation.

COMMERCIAL POTENTIAL: This effort has commercial applications in the automotive testing community.

REFERENCES:
1. Buhrman, J. R., "Vertical Impact Tests of Humans and Anthropomorphic Manikins," Air Force Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Interim Report, Report No. AL-TR-1991-0129, 1991. ADA245866

N95-152 TITLE: Reflective Coating for Aircrew Helmets

OBJECTIVE: To develop and field a coating for aircrew helmets that can replace the combination of paint and reflective sheeting that is currently in use in the U.S. Navy/Marine Corps.

DESCRIPTION: During search and rescue (SAR) operations, it is desirable to have the aircrew as visible as possible in order to expedite recovery. Currently, the main component seen by SAR aircraft is the helmet, especially if the downed aircrew member is in water. This is due to the white reflective tape that is applied to the helmet, in accordance with OPNAV Instruction 3710.7 (General NATOPS). Currently, Scotchlite® brand reflective sheeting is used (560/580 Series). This tape is applied over the paint that is applied during the manufacturing process. The taping process is extremely labor intensive, requiring 4-6 hours of labor by maintenance personnel. Due to cutbacks in personnel, it is desirable to develop an improved manufacturing process. The helmet must retain 100% reflectivity when wet and be durable enough to withstand the environment during normal use (salt air, humidity, scuffing, exposure to oils and hydraulic fluids). The coating must be capable of touch-up and cleaning without presenting any hazard to the wearer, maintainer, or the environment. This coating must be able to meet the reflective requirements specified in Federal Specification L-S-300C and coating requirements of MIL-C-46168D(ME). Application of the coating should not significantly effect the time or cost of production of the helmet.

PHASE I: Provide a technical and industry survey of current coatings that could be used or describe what steps must be taken in order to develop such a coating.

PHASE II: Use off-the-shelf technology or develop technology necessary to demonstrate the feasibility of coatings identified in Phase I.

PHASE III: Produce coated aircrew helmets for full operational testing and provide necessary data for introduction of coating into the Navy supply system.

COMMERCIAL POTENTIAL: New coatings developed can be used in a variety of applications, from road signs through painting of vehicular helmets for increased visibility under low light conditions. This coating, if flexible, may also prove useful in the marking of other equipment, such as life vests and rafts, used by boaters and aircrew in both military and commercial

markets.

REFERENCES:

1. MIL-C-46168D(ME), Federal Specification L-S-300C

N95-153 TITLE: CFD Analysis of Rocket Plume Effects on Ejection Seat Aerodynamics

OBJECTIVE: Wind tunnel testing has shown that the ejection seat rocket plume can significantly influence the aerodynamic behavior, especially at high angle-of-attack. These effects are compounded by multiple nozzle seat systems anticipated for the next generation of ejection seats. The prediction of the aerodynamic effects of the rocket plume is required for six-degree-of-freedom models for calculation of g-loads on the crewmember, ejection trajectory, and design of propulsion systems leading to improved emergency escape performance. Computational fluid dynamics (CFD) methods are needed to investigate rocket plume effects on the aerodynamic forces and moments acting on an ejection seat. The rocket plume model must take into account the effects of free stream Mach number, altitude, and nozzle exit thrust and/or flow rate. The model shall include the ability to evaluate a multi-nozzle configuration with arbitrary thrust levels over a wide range of free stream orientations, through Mach 1.5.

DESCRIPTION: Advances in computational processing capability have allowed CFD methods to become a cost-effective alternative to wind tunnel testing for analysis of complex flow fields. Given the ejection seat and occupant geometry, a computational domain shall be established of the surrounding flow field and rocket motor plume region. Consideration shall be given to the grid size and relative accuracy and convergence properties.

PHASE I: Provide a feasibility study by investigating the state-of-art in prediction of axi-symmetric rocket nozzle plume flows. Develop a Navier-Stokes CFD model and validate the prediction method against experimental data of a simplified fore body geometry. Develop a scheme to allow for a multi-nozzle configuration with modulating thrust levels.

PHASE II: Extend analysis to include a 3-D ejection seat configuration with multiple, variable thrust nozzles over a range of free stream conditions and orientations. Conduct limited wind tunnel tests to verify results. Conduct an extensive validation of the core solving routines.

PHASE III: A validated CFD code will be produced that will be applicable to a wide variety of applications in the military, space, and commercial sector. A simplified user interface shall be established and well documented so that a wide variety of systems can be evaluated. A library of components shall be established such as aero vehicles, seat systems, aero-dynamic stabilizers, and propulsion devices shall be established to aid the user in grid generation.

COMMERCIAL POTENTIAL: Any work to improve a CFD model is transferable to other models. Combustion engines in heavy equipment, race cars, civilian aircraft jet engines, etc., can benefit from an improved understanding in the heat transfer or multi-phase investigations aided by computational fluid dynamics methods. Material coating processes (high velocity oxygen fuel (HVOF), vacuum plasma (VP) spray guns would be another commercial application.

REFERENCES:

1. Reichenau, David E.A., "Aerodynamic Characteristics of a Half-Scale CREST Ejection Seat at Mach Numbers from 0.6 to 3.0, July 1988, AEDC-TR-88-6, AD-B123323.

N95-154 TITLE: Day/Night Ship Mounted Aircraft Approach and Landing Imaging Sensor

OBJECTIVE: To develop an imaging sensor capable of functionally replacing the Navy's existing obsolete visible recovery sensor.

DESCRIPTION: The Navy currently utilizes an Integrated Launch And Recovery Television Surveillance (ILARTS) System to simultaneously monitor launch and recovery operations. The system consists of six cameras of two different types. Three cameras are of interest. Two are mounted in the deck on the approach centerline positioned to cover the ranges of the optical touchdown point. The other camera is mounted on the island and can view approaches, deck operations, and launches. The in-deck cameras provide the Landing Signal Officer (LSO) with glideslope and lineup information. The cameras use Intensified ISOCON technology that is no longer available. The cameras mounted in the deck view the aircraft through a 150 mm lens (f3.5) and an optical relay system consisting of a telerelay lens, folding mirror and window assembly. The window and mirror are housed in a ballistic enclosure that has a 15/16 inch high by 2 inch wide opening. These cameras must provide good imagery

day and night which is exacerbated by the fact that aircraft approach with the landing lights on (a single 450 watt lamp). The aircraft itself is only illuminated by natural light. The interscene dynamic range is 10E6. Present technology cameras, such as those utilizing ISIT technology, exhibit unacceptable blooming at distances closer than 1500 feet. Other problems include: afterburners washing out images in low light levels, scintillation noise from the intensifier being always present, and long operational periods of 1624 hours reducing the life of the camera. The sensor must meet the following requirements: detect an aircraft at 5 nm, determine position relative to glideslope at 3 nm, identify aircraft type by either signature detail or light pattern at 1 nm.

PHASE I: Provide a design for a sensor that will be capable of meeting the requirements. The design should include a performance analysis and hardware description.

PHASE II: Develop and produce a breadboard sensor system that would demonstrate the required performance. The sensor will undergo an extensive landbased evaluation.

PHASE III: Integrate the sensor into the Navy's ILARTS system and evaluate the fully integrated operational system on a Navy ship

COMMERCIAL POTENTIAL: This technology has application in the private sector in the areas of general surveillance especially where a large dynamic range is required such as when the sun would be in the sensor's field of view and when intense light sources such as automobile headlights would be present in an otherwise totally dark area. This technology could also be utilized in the commercial home video market.

REFERENCES:

1. NAVAIR 516081 Technical Manual, Operation and Maintenance, Instructions with Illustrated Parts Breakdown, Integrated Launch And Recovery Television Surveillance (ILARTS) System.

N95-155 TITLE: Electric Energy Absorber System (EEAS) for Aircraft Recovery

OBJECTIVE: To develop an advanced electric aircraft recovery system for both the Navy sea based and Marine Corps land based fixed wing aircraft.

DESCRIPTION: The future aircraft proposed for the Navy and Marine Corps exceed the present MK 7 MOD 3 and E28 arresting systems' capabilities. The present systems rely on hydraulics to absorb the energy of the aircraft. The MK 7 MOD 3 is a linear device that is heavy, inefficient, and large. The MK 14 was developed as a rotary device that saved weight and volume, but relied on hydraulics for energy absorption. In light of the advances made in power electronic and control technologies, an electrical system offers a more reliable, controllable, and efficient approach. The Electric Energy Absorber System (EEAS) is needed to recover all the fixed wing aircraft of both services. The EEAS will provide a means of electrically arresting the aircraft and retracting the arresting cable, all with the same electrical device. Basically, the EEAS is an energy absorber that will absorb the kinetic energy of the aircraft by electrical means. And, because of the inherent high level of controllability of electrical power, the arrestment can be precisely controlled throughout the stroke, providing less stress to the airframe, thereby extending the airframe life.

PHASE I: During PHASE I, the contractor shall determine the optimum electrical absorbing device for an aircraft arresting application based on a tradeoff study. The contractor shall then proceed with a conceptual design of the entire EEAS based on the optimum device.

PHASE II: The contractor shall provide a detailed design of the EEAS. The contractor shall also provide a working scale hardware model of the EEAS, not less than 1/4 scale, energywise.

PHASE III: A transition to a 6.3 effort by the contractor will provide a full scale EEAS, capable of arresting loads representative of aircraft weights and landing speeds.

COMMERCIAL POTENTIAL: EEAS technology can be used as a high power electric dynamometer for testing of gas turbines, steam turbines, and electric motors. The technology can also be applied as a braking device for locomotives.

REFERENCES:

1. NAVAIR 515BCA1.1, VOLUME 1: TECHNICAL MANUAL; Operation, Maintenance and Overhaul Instructions; Aircraft Recovery Equipment MARK 7 MOD 3

N95-156 TITLE: Anti-Reflective Coatings for Aviation Helmet Visors

OBJECTIVE: Develop a coating to be applied to aircrew visors to decrease reflections seen by aircrew.

DESCRIPTION: As mission requirements placed on U.S. Navy/Marine Corps aircrew increase, the limits of the equipment used become more apparent. Aircrew note that glare, due to reflections both from the visors in front of the eyes and from other sources, decreases their ability to successfully complete the mission. It would be desirable to reduce the amount of reflective glare seen by the aircrew. This could be accomplished through the use of an anti-reflective coating applied to the visor lens. These coatings are to be applied to visor systems currently in use on USN/USMC aviation helmet systems. These visors have a spherical segment profile, are made of polycarbonate, and have a scratch-resistant coating. Sources must provide expected measures of performance; for example: transmissivity, weight of coating (per unit area), glare reduction, method of application, support requirements, etc. The coating must be able to withstand the environment associated with USN/USMC helmet systems (salt air, humidity, scratching, exposure to oils and hydraulic fluids), must not degrade either the integrity of the visor material, or the optical performance, and must be durable. It is desirable that the coating be field repairable if minor scratching occurs.

PHASE I: This phase should consist of a study of the coatings available and the methods that would be used to apply the coating. The study should address all areas of concern as described above and show the feasibility of the coating.

PHASE II: This phase should use the materials and processes outlined in Phase I to prepare a sufficient number of visors for laboratory and flight testing to determine user acceptability and performance.

PHASE III: Production and commercialization of effort.

COMMERCIAL POTENTIAL: Polycarbonate lenses are widely used in commercial activities, such as: eyeglasses, protective eyewear, motorcycle helmet visors, aircrew helmet visors. Any coating developed could be effectively used in all of these areas.

REFERENCES:

1. MIL-V-85374(AS)

N95-157 TITLE: Compact, High Power, Quick Reacting Storable Energy Sources.

OBJECTIVE: The objective of this project is to develop a compact source of electrical power which is capable of long term inert storage.

DESCRIPTION: The proposed project will examine electrical generation and storage technology to develop a safe and reliable alternative method of providing electrical power. Military applications of these devices are primarily in weapons or missile targets. In these applications, the devices are installed in the weapon/target at the time of manufacture. They remain inert through the shelf life of the weapon, and are activated only when the weapon is fired. The device must then immediately begin to provide electrical power sufficient to operate the weapon's/drone systems. It must maintain sufficient power throughout the weapon or target time of flight.

PHASE I: Phase I will require the developer to examine the state of the art in electrical storage technology. The objective in phase one will be to develop a PRACTICAL method of power generation which can achieve the rapid rise time of a thermal battery after prolonged storage, and sustain sufficient output for the entire time of flight of a typical missile or target. The storage device will provide a practical alternative to current technology. The device and the electrical generation process must be able to fit within the physical boundaries of the missile or drone and, in operation, must not adversely impact the vehicle systems.

PHASE II: During phase II, the developer will package and test the power generation system for use in aerial targets and/or missiles.

PHASE III: In the third phase, the system will be integrated into a selected target system identified in Phase II and tested.

COMMERCIAL POTENTIAL: The ability to provide electrical power from an in-circuit device that is inert and storable until use would find commercial application in many areas, particularly for emergency relief. As an example, in emergency lighting systems, or as power for emergency communication systems. In earthquake response kits electrically operated devices could be included without the current constraints of battery shelf life.

N95-158 TITLE: Modeling Characteristics for Volumetric Explosives

OBJECTIVE: Develop a model for evaluating Fuel Air Explosive (FAE) reactions based on the detonation parameters for particulate clouds.

DESCRIPTION: The conditions affecting whether a FAE cloud will sustain a steady state detonation include the material properties, dispersion parameters, initial boundary conditions, and initiation source. These include, in particular fuel chemical composition, particle size distribution, particle shape distribution, surface to volume ratio, particle solid density; fuel and oxidizer concentrations and cloud diameter; ambient temperature, pressure, and humidity; and, initiation source type, duration, and location. These are among the parameters which determine the rate of energy release and the total energy released from the reaction of a FAE cloud.

PHASE I: Assemble the parametric equations and data necessary for constructing the model. Identify and assess modeling techniques/approaches appropriate to this problem. Select the approach to serve as the basis for Phase II based on these findings.

PHASE II: Develop a model which utilizes detonation parameters and which allows for the varying of input parameters (e.g. fuel type, etc.) to evaluate FAE reactions. Complete a final report detailing the model.

PHASE III: The model will be transitioned to the government. It is expected that the contractor will provide written documentation, assistance and consultation necessary for installing the model on government computers and support necessary for government users to begin operating this model.

COMMERCIAL POTENTIAL: This model has application in the private sector to industrial hazards and accidents involving solid particulate explosions.

N95-159 TITLE: High Energy Density Fuels for Solid Fuel Air Explosives (FAE)

OBJECTIVE: Develop techniques for laboratory scale production of fine coatings on reactive metal powders to be used in volumetric explosives.

DESCRIPTION: Current enhanced blast volumetric explosive fuels have particle sizes ranging from 15 to 45 microns (μ). New processing techniques have enabled the production of solid particulates in sizes of approximately one to three μ with a variety of coatings. Current production capabilities can provide material quantities on the order of grams (g). Laboratory experimentation to characterize reactive powders with coatings for use as solid fuels in explosives and propellants requires quantities on the order of tens of pounds.

PHASE I: Identify processing techniques for producing μ size coated particulates. Assess their applicability for the production of reactive metal powders of interest as solid fuels. Identify facilities which could provide laboratory scale-up production. The contractor is to provide a report identifying processing techniques and facilities available for producing reactive metal powders.

PHASE II: Develop a detailed understanding of the coating process, including the effects of coating reactive metal and/or binder concentration, particle size, and coating thickness. Develop a process and design of scale-up facilities for the continuous or batch production of useful quantities of metal fuel particulates. Provide 100g to 500g (or larger) samples of a variety of very fine reactive metals coated with a number of different metals or binders for safety and performance evaluations at NAWCWPNS, China Lake. Complete a final report describing the process and analysis on the materials.

PHASE III: Evaluate the performance and the producibility of the materials for practical explosive applications. Conduct toxicity assessment on the optimum material. Transition to production level scale-up and processing.

COMMERCIAL POTENTIAL: Weaponization involving reactive metals with coatings will require facilities capable of pilot or full-scale production processing. Activation/pacification of small particulates with coatings could have potential application in several industries from pharmaceuticals to metallurgy.

REFERENCES:
1. C. Gotzmer, W. Felder, R. Gill, K. Harrity, *Preparation of Reactive Boron Powders*, presentation Naval Surface Warfare Center/White Oak; W. Felder, *Vapor Coating of Boron Particles by Magnesium*, AeroChem Research Laboratories, Inc. AeroChem TP-479, Contract No. N60921-88-C-0134, Draft Copy, December 1988, prepared for Naval Warfare Center/White Oak;
2. W.T. Rawlings, R.R. Foutter, T.E. Parker, *High Temperature Ignition of Coated Boron Particles in a Shock Tube*, Final

Report, Contract No. N60921-91-c-0188, Physical Sciences Inc., PSI-2176/TR-1171, February 1992.

N95-160 TITLE: Passive Techniques To Eliminate Combustion Instabilities

OBJECTIVE: The objective is to develop passive techniques to change the natural acoustics for a given combustor. Ramjet engines will be emphasized, but this work can apply to industrial burners, turbines or any combustor.

DESCRIPTION: Combustion instabilities are an extremely complex phenomena which cannot be accurately modeled. They are often, however, associated with the natural acoustics of the ramjet engine. If energy is added at a pressure node of the natural acoustics, then the acoustic energy is increased leading to combustion instabilities (Rayleigh criteria). Modifying the natural acoustics of the engine could allow control over combustion instabilities since the pressure nodes could be moved away from the energy source.

PHASE I: Phase I will be a feasibility study. A detailed literature review on the attenuation and regeneration of sound in straight ducts and curved ducts needs to be conducted. Existing knowledge must be expanded and applied to ramjet environments where mass flowrates, temperature and gaseous reactants affect the natural acoustics. Passive techniques which alter the longitudinal and transverse modes of the ramjet will be modeled and evaluated for testing.

PHASE II: Phase II will consist of testing the proposed techniques in combustion environments, though initial tests may be noncombustive. Ultimately, the passive techniques will be tested for their ability to change a high amplitude oscillation in one mode to a low amplitude oscillation in a different mode. Testing must occur for center dump and side dump combustor configurations to evaluate the robustness of the passive techniques. Data on combustion efficiency and pressure loss must be analyzed to determine if there are adverse affects on overall combustor performance.

PHASE III: Phase III will contain engine performance mapping for a simulated mission. The top performing passive techniques from Phase II will be tested and compared to results without the passive technique. Combustion efficiency, pressure recovery, lean blowoff and combustion instability measurements will be compared.

COMMERCIAL POTENTIAL: The ability to change the natural acoustics of a combustion chamber has direct application to industrial burners for noise reduction or performance enhancement by eliminating instabilities. The technology may also lead to better acoustic manipulation for noncombustive systems, such as airconditioning and heating ducts.

REFERENCES:
1. Basic Considerations In The Combustion Of Hydrocarbon Fuels With Air, National Advisory Committee for Aeronautics, Report 1300, Chapter VIII, Oscillations In Combustors, 1959.
2. Combustion Instabilities in LiquidFuelled Propulsion Systems, Advisory Group For Aerospace Research & Development, AGARD Conference Proceedings No. 450(AGARDCP450). ADA211109
3. Air Force Wright Aeronautical Laboratories, Ramjet Combustor Instability Investigation: Literature Survey and Preliminary Design Study, by R.C. Waugh, et al. United Technologies Chemical Systems, San Jose, Ca., September 1983. (AFWALTR832056 Vol. 1, report UNCLASSIFIED.)
4. Clark W.H. and Humphrey, J.W., Identification of Longitudinal Acoustic Modes Associated with Pressure Oscillations in Ramjets, Journal of Propulsion, Vol. 2, No. 3 MayJune 1986.
5. Byrne, R.W., Longitudinal Pressure Oscillations in Ramjet Combustors, AIAA/SAE/ASME 19th Joint Propulsion Conference, Seattle, Washington, June 2729, 1983 (AIAA832018).

N95-161 TITLE: Pulse Width Modulated Valves for Liquid Fuel Control

OBJECTIVE: The objective is to develop an inexpensive, compact, digitally controlled fuel valve for use with liquid fueled ramjet engines. This work may also apply to other airbreathing propulsion engines, such as turbines, pulse detonation engines and scramjets.

DESCRIPTION: Good performance of a liquid fueled propulsion system for a wide range of operating conditions requires a means for metering the fuel flow to the engine. This has been accomplished in the past by an electromechanical cavitating venture valve, fluidic control valve and other technologies. These valves in general have been high cost, have a high pressure drop and are relatively large. The current state-of-the-art valve fits into a 3" x 4" x 6" box. Gains in liquid fuel missile propulsion performance can be realized with higher density, higher viscosity fuels which become attractive with compact, low cost, lightweight fuel management components.

Pulse Width Modulated (PWM) valves have been developed for the automotive and space industries. PM valves offer the advantage of compactness, in line installation with the fuel line(s) and integrated electronics. Their use in the automotive industry has dictated a need for low costs, low operating pressures (< 100 psi) and compatibility with a liquid fuel. Those used in the space industry are generally for pneumatic and hydraulic applications at very high pressure (>3000 psi) with large pressure drops. The operating frequency for these valves has been less than 200 Hz.

The current needs for a ramjet engine require moderate operating pressures up to 500 psi for a maximum fuel flow rate of 11.5 Gam; or for a maximum fuel flow rate of 2.9 gam. If four valves are used in parallel. The pressure drop across the valve should be minimal (<50 psi) at the maximum fuel flow rate. A fuel management system study has shown that a fuel flow rate turndown ratio of 15:1 is needed. The current technology in PM valves offers a metering capability of about 4:1.

A large variation in fuel flow rate delivery to combustor is not acceptable, thus higher operating frequencies or a means of damping the fuel flow perturbations downstream of the valve is needed. This is desired while maintaining a size and cost commensurate with automotive PM valves.

PHASE I: PHASE I will be a feasibility and design study. The feasibility of simultaneously meeting the above needs will be addressed and documented. A design effort will then be conducted to substantiate the feasibility and provide a preliminary design for Phase II. Other issues to be addressed are accuracy, repeatability, method of control and compatibility with JP10 and RJ7.

PHASE II: Phase II will consist of a detailed design effort followed by prototype fabrication and performance testing. Also, testing shall be conducted on the prototype valve to ensure survivability during missile captive carry, launch and flight environments. A limited production run of four units each of a high flow rate valve and ten units each of a lower flow rate valve, will occur after prototype testing has been completed. These valves shall meet the needs specified and agreed to during the preliminary and detailed design efforts.

PHASE III: PHASE III will consist of military production and commercialization.

COMMERCIAL POTENTIAL: The commercial market for PM valves may be expanded through development for this new application, especially if the valves are applicable to the turbine engine industry.

N95-162 TITLE: Weapons Quality Q-switched Laser

OBJECTIVE: The objective of this project is to design, fabricate, and test a Q-switched solid state laser which will meet the requirements for a weapon system while maintaining a low cost per device.

DESCRIPTION: Laser initiation for advanced warhead applications requires the use of Q-switch technology to achieve initiation rates comparable to exploding fail initiator and exploding bridge wire devices. Most existing Q-switch technology is unsuitable for ordnance systems applications due to cost and complexity considerations. Active systems (electro-optic, acousto-optic, rotating mirror devices) increase the size, complexity and cost of the laser system beyond the practical limits for a one shot costly, and preclude the option of plating an output coupler directly to the laser rod. The laser system should be rigged enough to meet military specifications for vibration, operating temperatures, and prolonged storage without requiring optical adjustment.

PHASE I: Develop preliminary design approaches and evaluate feasibility.

PHASE II: Design and demonstrate prototype devices. Design goals are:

- Laser should survive 50 shots at maximum power without degradation.
- Laser should survive MILSTD810 testing without loss of alignment.
- Device should be capable of 15 yr. shelf life
- Performance and shelf life should not degrade with exposure to temperature extremes (55C to 160C)
- Peak power density: >5 MW/mm^2
- Pulse duration: <20 nsec
- Cost in quantities >100: not to exceed $200 each

PHASE III: Transition to military ordnance community. Determine interest in medical/surgical community and industrial applications.

COMMERCIAL POTENTIAL: A device meeting the above specifications would have immediate application in industrial laser processing, including cutting, welding, heat treating, drilling, cladding, surface alloying. Medical applications are rapidly evolving as well.

REFERENCES:
1. L. C. Yang, Vincent J. Menichelli. "Detonation of High Explosives by a Q-switched Ruby Laser.: Journal of Applied Physics, Vol. 45, No. 6 (June, 1974), pp 26012608.

N95-163 TITLE: 3-Dimensional Perspective Transformer at Video Rates

OBJECTIVE: Develop an image processing engine to perform 3D perspective transformations of imagery at video rates.

DESCRIPTION: Navy air-to-ground targeting, usually requires the operator, to detect the target from a mission planning asset that is nothing more than a hardcopy of a picture. In many instances pilot workload becomes an overriding factor, and there is not ample time to find the target. Many human factors studies have shown that by warping the imagery (rotating, scaling, translating etc.) to the perspective of the human operator we can decrease the time required to perform the targeting function, while increasing targeting effectiveness. At present there exists hardware to perform 2D warping of imagery at RS170 video rates. There is talk in the TACAIR community about storing imagery in the Digital Map System (DMS). With this imagery and an elevation database one could vastly improve Air-to-Ground targeting effectiveness.

PHASE I: Outline the system requirements, establish what resources will be required to perform realtime 3 axis warping of imagery, and produce an initial system design and execution plan on paper.

PHASE II: Build a prototype 3 axis warper based on the Phase I results.

PHASE III: Integration of the 3 axis warper into our realtime image processing facilities.

COMMERCIAL POTENTIAL: Includes commercial aircraft, train and automobile trainers and simulators, as well as medical imaging applications.

REFERENCES:
1. "Digital Image Warping" Wolberg 1990 IEEE Computer Press

NAVAL SEA SYSTEMS COMMAND

N95-164 TITLE: Develop Test Concepts and Techniques to Quantify the Free Field Safety Level of RF Induced Body Currents and RF Burn in Humans

OBJECTIVE: Develop test concepts which can be used to measure the amount of induced RF current that would flow through a human body when immersed in a RF field. Test concepts should also address the current flow through the wrist when grasping rigging in a high RF field. It is also desirable that test concepts be developed that would address the likelihood that a person would receive an RF burn resulting from contact with metallic items located in a high RF field. The frequency range of interest is .003 to 100 MHz, RF current range is 0 to 250 ma. Test concepts should be capable of being performed by personnel in a naval ship environment, in port and at sea, as well as on land. Test time aboard ship is a major attribute.

DESCRIPTION: Naval ships contain a large number of high power transmitters in a limited amount of real estate causing areas of high RF environments which creates a radiation hazard (RADHAZ) safety problem to personnel. These high environments limit personnel activities associated with the operation of naval ships. There is also a large quantity of metallic rigging which captures the RF energy thus causing a potential radiation hazard safety situation when grasped or touched. ANSI/IEEE C95.1-1992 contains limits for induced body current through the feet/ankles for free standing persons and current through the hand/wrist in a grasping situation. There is no criteria for RF burn. The Navy utilizes 140V as a indicator of RF burn potential.

PHASE I: Develop at least 4 possible test concepts by which the sought after measurements can be obtained. Develop a performance baseline for these concepts and perform those trade off studies necessary to define the preferred test concept.

PHASE II: Develop/procure the necessary hardware for measuring the RF induced current for both ankles and wrist as well as RF burn if addressed in phase I. Develop the necessary validation criteria which will be used to verify that the test concepts and equipments measure the RF currents that would be induced into a human. Execute the test at the Naval Surface Warfare Center Dahlgren Division, Dahlgren, Va.

PHASE III: The successful results of phase I and II will transition to the Ship Electromagnetic Compatibility Improvement Program (SEMCIP) managed by SEA 03K23. Funding will be provided to procure the necessary hardware and execute Radiation Hazards Certification of naval ships. SPAWAR 10 will transition results for RADHAZ certification of shore sites.

Should any new equipment be developed the contractor will be the source for procurement as well as responsible for training government/contractor personnel in the utilization of the test equipment and test concept.

COMMERCIAL POTENTIAL: The ANSI/IEEE C95.1-1992 is applicable to both government and commercial establishments which install/operate RF transmitting equipment, i.e. hospitals, communication companies, radio stations, security firms.

REFERENCES:

1. American Conference of Governmental Industrial Hygienists(ACGIH), "Threshold limit Values (TLVs) and Biological Exposure Indices for 1992-1993," 1992.
2. American National Standards Institute (ANSI) C95.2-1981, "American National Standard Radio Frequency Radiation Hazard Warning Symbol," 1981.
3. Institute of Electrical and Electronics Engineers (IEEE) C95.3-1991, "IEEE Standard Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave," August 21, 1992.
4. MIL-STD-882C, "System Safety Program Requirements," January 19, 1993.
5. Institute of Electrical and Electronics Engineers (IEEE) C95.1-1991, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," April 27, 1992.

N95-165 TITLE: Develop and Produce a Real-Time Ultrasonic Weld Evaluation System

OBJECTIVE: Develop automated ultrasonic inspection system to perform real-time weld evaluation.

DESCRIPTION: A 1989 the Navy concluded that, in certain cases, ultrasonics is an acceptable alternative to radiographic inspections. As a result, in accordance with MIL-STD-1688, ultrasonic inspections are now allowed in place of radiographic inspections. Additional savings in inspection costs, along with improvements in quality and reliability could be provided with improved characterization of the discontinuities in the weld metal.

Currently, the Navy (NAVSEA 08) is using ultrasonic systems which automate the data collection process for in-service inspections. The analysis and interpretation of the signatures still requires both post-processing and human interaction, which is labor intensive and requires considerable training. Laboratory research at the Naval Surface Warfare Center has demonstrated that automatic sizing and classification of the weld discontinuities is now possible with current advances in sizing technology and classification algorithms. Thus, to reduce inspection costs, the Navy requires a real-time system which is capable of automatically sizing and characterizing the discontinuities. Such an automated system will yield improved quality assurance and permit improved acceptance criteria standards reducing the number required inspections and repairs.

Capabilities of this real-time system should support discontinuity detection and sizing, classification of the discontinuity type (ie. crack, lack-of-fusion, porosity, void, etc.), and application of an acceptance criteria. The acceptance criteria should parallel MIL-STD 2035(SH), and incorporate the capability to accept or reject the discontinuity based on: the ultrasonic signature amplitude, size of the discontinuity, proximity of neighboring discontinuities, and the type of the discontinuity. This system must support inspection of hull welds under as-welded conditions, thus the capability for both angle-beam and normal-incidence inspection modes is required. In addition, in order to support transition of technology to the fleet, the system must support in-field manual inspections, whereas the inspector is aided by the equipment to determine the discontinuity size, type and acceptability.

PHASE I: Develop and investigate techniques to perform discontinuity detection, sizing, and classification. Identify limitations of techniques as applied to in-the-field hull weld inspections. Identify automated ultrasonic equipment to support real-time inspections and identify hardware/software interface requirements.

PHASE II: Develop and demonstrate a system on Type I hull welds at laboratory and field trial sites. Demonstration of the system is required for both a manual inspection, and a fully automated inspection in real-time. Develop licensing and commercial production requirements.

PHASE III: Transition the system to the Navy, for example, the Naval Joining Center, and the Naval Surface Warfare Center, where the system can be demonstrated for a wide range of applications.

COMMERCIAL POTENTIAL: This technology has direct application to commercial shipyards, for example, Bath Ironworks, Avondale Industries, General Dynamics, and the piping industries.

REFERENCES:

1. L.M. Brown and R. DeNale, "Computer Assisted Weld Inspection", in Proceedings, 1994 Innovation Symposium, 7-9 September 1994, Pittsburgh, Pennsylvania, American Society of Naval Engineers, pp. 507-517.

2. "Ultrasonic Inspection Procedure & Acceptance Standards for Hull Structure Production & Repair Welds", NAVSEA 0900-LP-006-3010 (Jan 1966).
3. "Nondestructive Testing Acceptance Criteria", MIL-STD 2035(SH)(1991).

N95-166 TITLE: Universal Portable Communicator

OBJECTIVE: Produce an affordable, universal, portable, personal communicator for tactical and administrative intra-ship communications by all Navy shipboard personnel. Device would be used in lieu of current wired shipboard communications systems as last link from sailor to the communications network. Device shall comply with emerging and current FCC standards for narrow-band digital systems, and shall inter-operate on multiple disparate networks. Performance in congested shipboard EMI/EMC environments shall be demonstrated in Phase II. Units must as light weight and low cost as emerging digital cellular and Land Mobile Radio (LMR) products. In addition to voice, unit would also handle data and slow speed video.

DESCRIPTION: Design and produce hardware and software to be hosted in a portable communicator to allow interoperability of a universal communications device within disparate networks.

PHASE I: Analyze Land Mobile Radio, Cellular, and Personal Communication System networks. Determine each systems modulation schemes, operating frequencies, and interface requirements. Interfaces to be addressed include security, including Type I, Common Air Interface (CAI), and Common Network Interface (CNI). Demonstrate portable communicator interoperability with multiple networks.

PHASE II: Determine telecommunications services for all ship to ship, ship to shore, and on-shore links. Establish applicability, survivability, and interoperability links with ship and shore based communications infrastructure. Produce a demonstration model digital wireless communicator compliant with FCC standards operable in the congested shipboard EMI/EMC environment.

PHASE III: Demonstrate transfer of voice, data, and video information among disparate networks. Demonstrate operations in a small scale joint Military exercise.

COMMERCIAL POTENTIAL: Industry could use a universal portable communicator within the commercial infrastructure of disparate Land Mobile Radios (LMR) and cellular systems.

N95-167 TITLE: Develop System for Gas Turbine Duct Noise Cancellation

OBJECTIVE: Attenuate airborne gas turbine and ventilation fan system noise transmitted through intake and exhaust ducting to critical ship spaces.

DESCRIPTION: Develop a noise cancellation system suitable for both quieting a variety of duct configurations and shipboard compartment arrangements. Demonstrate active noise cancellation at a gas turbine facility.

PHASE I: Develop a realtime simulation model/design tool of a noise cancellation system to demonstrate noise attenuation throughout spaces in a ship and system design approach, respectively. Compare the model results with current shipboard practices.

PHASE II: Design, develop and test a prototype noise cancellation system based on the accomplishments of Phase I. Demonstrate noise cancellation on 3MW (or greater) gas turbine intake system at either a commercial or government facility. Revise the design tool and simulation model and prepare documentation for their use. Develop ship system implementation design and cost benefits analysis for a destroyer class vessel.

PHASE III: A successful prototype is expected to be incorporated into the next new Navy ship design. Final design development and testing shall take place in Phase III to ensure performance in a Navy shipboard environment. The noise cancellation system shall be develop to withstand corrosion, vibration, shock and EMC/EMI environments as well as demonstrate reliable operation. The offeror is expected to participate with the ship designer and builder for the final design of the noise cancellation system.

COMMERCIAL POTENTIAL: This technology would have application in commercial building ventilation systems, automotive compartment comfort, mobile land based offices and facilities, and basically any enclosure requiring noise attenuation without the use of passive treatment systems. The advantages of reduced material acquisition, simplified construction, reduced weight, reduced volume are all applicable to both the commercial sector as well as military systems.

N95-168 TITLE: Develop a Low Cost Fiber Optic Switch

OBJECTIVE: Develop low cost, reliable, and easily manufactured multimode fiber optic switches by using arrays of micromachined switching elements.

DESCRIPTION: Optical communications and sensor systems are planned for future use on Navy ships such as AEGIS cruisers. The Fiber Optic Data Multiplex System needs rugged 2X2 multimode switches to bypass nodes for shipboard use. Current relay type optical switches experience transient upsets during physical shocks that lead to signal loss. Low loss solid state switches are not available for multimode optical fiber systems. Hence, optical switches utilizing arrays of moveable mirrors based on micromachine technology would be more shock insensitive than current relay type optical switches and still have low losses. This technology has been demonstrated in the coupling of light into laser cavities.

PHASE I: Design and demonstrate a concept for producing multimode, broadband fiber optic switches. The design should demonstrate beam steering between and input optical fiber and two output optical fibers using a micromachined mirror array.

PHASE II: Optimize switch design for use in the Navy SAFENET Optical Communications System. Construct several prototype 2X2 non-latching optical switches utilizing micromachined mirror arrays. Perform temperature, shock and vibration characterization of candidate switches. Establish procedures for economical mass production of switches.

PHASE III: Transition to the Fiber Optic Base Technology Program. Construct a ruggedized switch for laboratory testing followed by sea trails in a SAFENET application.

COMMERCIAL POTENTIAL: Multimode fiber optic switching is currently a slowly developing market sector because of the difficulty in reliably producing quality switches. Micromachine manufacturing processes would streamline multimode fiber optic switch manufacturing, increase switch reliability, and reduce switch costs. The Micromachine Mirror technology has applications in 1XN switch designs and, control of laser diode alignment and laser cavity tuning.

REFERENCES:
1. MilSpec 24725.

N95-169 TITLE: Magnetic Bearing Shock

OBJECTIVE: Demonstrate capability of magnetic bearing system technology to operate through MILS901, Grade A, shock impact within minimal volume constraint.

DESCRIPTION: Develop, design, produce and test a three bearing single rotor system (two radial, one axial) to demonstrate operation through a shock environment and limits of operation in loss of levitation. The magnetic bearing system should be design with the intent of eventual development for aircraft and aircraft derivative gas turbine engine application. Disseminate the technical information to the design community.

PHASE I: Design a three bearing single rotor system, levitation and controller that can be scaled up for a 5000 lb rotor. Develop a simulation system to evaluate the performance of the system under preshock, shock, and post shock operation.

PHASE II: Develop a magnetic bearing rotor system for shock evaluation. The suspended rotor weight shall be greater than 500 lbs. Demonstrate operation of the bearing system through a MILS901 Shock. Revise the design tools and the simulation model based on shock evaluation. Prepare simulation model and related technical information for dissemination.

PHASE III: Design, build and test a magnetic bearing system for a nominal 30005000 Kw generator rotor that may be suitable for marine application. Install the magnetic bearing in a commercial generator set for extended evaluation.

COMMERCIAL POTENTIAL: There is not expected to be a lot of commercial potential for shock worthy magnetic bearing system designs. This is a primarily military requirement that must be satisfied in order to consider magnetic bearing technology for naval platforms. However, the limited commercial applications may include critical applications such as a vibration-less feed of machining/milling operations, and also for handling tools used by numerical control machines.

REFERENCES:
1. MIL-S-901

N95-170 TITLE: Develop Electric Starter Motors for Ship Propulsion Gas Turbine

OBJECTIVE: Develop an advanced motor, e.g., variable reluctance motor, etc., and associated electronics as a starter for an advanced ship propulsion gas turbine.

DESCRIPTION: Ship propulsion turbines are currently started by air motors energized from a high pressure (HP) air system. Electrically energized starter motors would significantly reduce the requirements and cost of shipboard air systems, improve system reliability, and reduce start times over those resulting when several other ship equipments must be started before the turbine.

The starter motor design should consider those factors that affect the design of potential power sources such as battery banks and small (under 500 KW) generator sets. The starter motor shall have a nominal rating of 270 horsepower. More specifically, it must have the following speed torque characteristics: 1) speed range of shaft 0-2800 rpm, torque 500 lbs.-ft (constant), horsepower as determined by speed-torque; 2) speed range of shaft 2800-4600 rpm, torque as determined by speed-torque, horsepower 270 (constant). The air motor currently used has a maximum rotor speed of 22,000 rpm and gears down the shaft speed to those mentioned above. The air motor is 11.89 inches long (including gear) and has a diameter of 9.73 inches. The electric motor (including any necessary gearing) must have a similar diameter, but may be as long as 21.25 inches (The extra length is obtained by removing the HP air piping feeding the air starter). The ambient temperature can range from 32°F to 190°F. The motor must be capable of surviving a 30g shock and have a mean time between failure (MTBF) of at least 20,000 hours. Other performance requirements, e.g., duty cycles, turbine coupling, mechanical and mounting arrangements, etc., will be provided by NAVSEA.

PHASE I: Develop the design of a full scale starter; identify required power, cooling air, wiring, power supplies, etc., prepare drawings, parts lists, etc. At the end of phase II, starter specification should be sufficiently complete to begin manufacture in the next phase. Provide report.

PHASE II: Manufacture prototype starters to the phase I design. Manufacture 2 units, first to be a functional brassboard model, second to be a pre-production prototype. Both units must be fully functional to allow testing of the starter concept and unique features. The starter will be evaluated on a ship propulsion gas turbine now in development. Provide report.

PHASE III: Conduct full scale testing, correct deficiencies, procure ILS and transition to production.

COMMERCIAL POTENTIAL: The advances in motor technology, in power semiconductor technology, and digital controls make this application challenging but achievable.

REFERENCES:
1. Technical Specification, SP-92-006, WEC, 15 October 1992.
2. Schell, Joseph A., "Alternative Gas Turbine Starting Systems", CDNSWC-TM-27-91-32, May 1992.
3. Ferreira, C.A., and Eike Richter, "Detailed Design of a 250-kW Switched Reluctance Starter/Generator for an Aircraft Engine", SAE Technical Paper 931389.
4. Radun, Arthur, and Eike Richter, "A Detailed Power Invertor Design for a 250 kW Switched Reluctance Aircraft Engine Starter/Generator", SAE Technical Paper 931388.
5. Radun, Arthur, James P. Lyons, James Rulison, Peter Sanza, Eike Richter, Dynamic Testing of a High Power Invertor 250kW Switched Reluctance Machine Starter/Generator, presented to SAE in April 1994.

N95-171 TITLE: Develop Improved Electronic Classroom Human Interfaces

OBJECTIVE: Research new/emerging technologies to increase the training efficiency by improving the human interfaces of the Electronic Classroom.

DESCRIPTION: NAVSEA fielded electronic classrooms that introduced new technology into the traditional classroom environment. This new technology came from computer, communication, and multimedia fields. It did not have a human interface component. The gains achieved by the Electronic Classroom will only be maximized when the human interface also benefits from advancements in technology.

PHASE I: The contractor will investigate man/machine interfaces specifically dealing with computers and communications systems. The research will focus on methods to improve the interface that will have a direct benefit on efficiency of the Electronic Classroom. The contractor will develop prototype hardware and/or software to test areas of greatest potential efficiency.

PHASE II: The contractor will install and test in the Electronic Classroom environment those prototype hardware

and/or software outputs of Phase I that are judged viable. The contractor will modify these products as required by the unique requirements of the Electronic Classroom environment and the continuing state-of-the-art technology advancements. Metrics will be established and data collected to determine relative efficiency gains in the Electronic Classroom from employment of this technology.

PHASE III: Those products of Phase II that are judged to be cost effective will be identified to the Office of Training Technology (OTT) in the Chief of Naval Operations (Office N7) for consideration for Navy-wide implementation. The Chief of Naval Education and Training (CNETT) will be appraised of results for use in the Navy school-house environment. The contractor will assist in implementation of selected products in additional Navy Electronic Classrooms over and above those tested in Phase II. Copies of all reports/evaluations will be forwarded to the OSD level for potential tri-service/inter-governmental/private sector utilization.

COMMERCIAL POTENTIAL: The advancement of the Electronic Classroom through improving the man/machine interface will benefit anyone with a training requirement that can use this technology. Training is a requirement of industry, government, and the military. The need to improve the efficiency of training is shared by all.

REFERENCES:

1. Course Reduction Demonstration Project Final Report, Navsea 04Mp 10/92

N95-172 TITLE: Develop Improved Solid State Neutron Detector

OBJECTIVE: Develop a solid state device which measures neutron intensity at background levels.

DESCRIPTION: Develop hand-held solid-state based neutron detector for portable instrumentation. The unit should be no larger than 2" diameter and 8" long with a detector area no larger than 4" by 4". The unit should operate for at least 40 hours with 2 D-cell batteries. The unit should detect background neutron radiation at an intensity of 0.01 milliREMs per hour within one minute of operation. The prototype unit may be a stand-alone unit for demonstration purposes. The ultimate goal is to operate the probe with the Multifunction RADIAC system.

PHASE I: Develop a preliminary design for a solid state device which measures neutron intensity at background levels, and conduct research to confirm that topic design objective will met.

PHASE II: Construct prototype detectors for use with Multifunction RADIAC System.

PHASE III: Develop production model for Navy use. This will be the transition to production phase.

COMMERCIAL POTENTIAL: This device will be useful to commercial nuclear power plants and commercial site restoration businesses.

REFERENCES:

1. Fabrication Specification for the Multifunction RADIAC System.

N95-173 TITLE: Develop Passivated Pyrophoric Metal Powders

OBJECTIVE: Eliminate the fire and explosion hazards associated with handling dry pyrophoric powders, such as Hafnium (Hf)

DESCRIPTION: Material Safety Data Sheets on many dry metal powders such as Hafnium (Hf) indicate possible fire and explosion hazards especially when handling in particle sizes below twenty microns in diameter. Research at NSWC labs on coating such metal powders with various polymers and plasticizers demonstrated desensitization in air, however, abrasion of the coatings occurred when mixing in propellants and explosives resulting in sensitive energetic compositions. The offeror's proposal should describe or exhibit an understanding of significant aspects of this problem and propose techniques to passivate that do not abrade, such as surface nitridation and metal microencapsulation. Of interest are the desensitization techniques and experimentally measuring the level of desensitization via established hazards tests such as electrostatic discharge tests (ESD).

PHASE I: Effort should be directed towards experimentally proving the feasibility that Hf powders can be desensitized via nitridation and metal microencapsulation or other techniques that do not abrade. Experiments may be carried out at the one gram or less scale. ESD tests may be accomplished by NSWC.

PHASE II: Effort should further develop the desensitizing techniques and experimentally verify the desensitizing effect. Particle size effects may also be explored. Fifteen kilograms of the desensitized Hf powder should be forwarded to NSWC for evaluation in energetic compositions during Phase II. Phase II effort should gather the chemical engineering data

necessary for scale-up in Phase III to large quantities of the desensitized Hf powder and extension to other metals.

PHASE III: Military applications that would benefit from this technology are broad and encompasses propellants, explosives, pyrotechnics and reactive materials.

COMMERCIAL POTENTIAL: Industries that are interested in the technology for new abrasives, new intermetallic preparation techniques, production of dry metal powders for industrial use. Microencapsulation could lead to new catalysts at less cost.

REFERENCES:
1. MSDS on Hafnium powders: R. H. Nielsen, "Hf and Hf Compounds", Kirk-Othmer Encyclopedia of Chemical Technology, 3rd Edition, Vol. 12, John Wiley & Sons, NY, 1980, pp 67-80.

N95-174 TITLE: Develop a Fuel Fume Environmental Recovery System (FFERS)

OBJECTIVE: Recover the fumes from conventional fuel that are emitted from ships' fuel tank vents, returning the fumes to liquid state into the tanks, thereby eliminating the fume emissions, preventing the explosive risk and conserving the fuel energy. This technology is applicable to military, merchant, and commercial fuel transfer operations.

DESCRIPTION: Ships store conventional fuel in enclosed tanks, some or all of which are vented to the atmosphere. Whenever ships received, offload or conduct internal transfers of fuel, the vents emit noticeable fumes. When receiving fuel, the transfer rate is such that substantial fumes are emitted resulting in hydrocarbon air pollution, severe risk of fire, and loss of potential fuel energy. A mechanism to recover the fumes and return the hydrocarbons to liquid state is needed for considerations of environment, energy and fire risk. The means to recover fumes could be either part of the fueling delivery apparatus, such as on the fueling pier, or inherently added to the ship. In the case of Navy ships which routinely send and receive fuel while at sea and daily conduct internal transfers of fuel, the preferred mechanism would be a shipboard system. The purpose of the fuel fume environmental recovery system (FFERS) would be to collect and condense the fumes, conduct necessary filtering, processing, or cooling, and return the fuel to storage tanks.

PHASE I: The technology to collect, recover and condense fumes in a large volume, high flow rate shipboard environment would be developed. Design considerations would need to ensure FFERS would not diminish the ship's design fuel transfer rate and would meet the requirement to maintain the fuel below the Navy's minimum acceptable flash point of 140 degrees Fahrenheit. Some technology may be transferred from the low pressure, low volume gasoline vapor recovery mechanisms now being used at some automobile gas stations. Determine the specific classes of U.S. Navy and MSC ships that could utilize FFERS, including Nuclear powered ships, which carry conventional fuels. Define the system capability parameters since each class of ship will have different fuel capacity and transfer rates, which drives a variety of FFERS models. Design the system capabilities to comply with the most stringent Environmental Compliance Regulations of Air Pollution currently in U.S. ports, and to enable measurement of the quantity of recovered fuel.

PHASE II: Develop the prototype(s). Conduct testing and Navy approval of a prototype. Install the unit onboard a ship. Conduct import and at sea testing to include receiving, off-loading and internal transferring of fuel. Upon initial successful evaluation and refinements, install further prototypes either on all ships in a particular class of ship or all ships in a particular port. Conduct analysis to determine the fuel costs savings incurred and the amount of air pollutant emissions averted. Further develop prototypes and/or installations for other Navy ships

PHASE III: Conduct further development of models for other Navy and MSC ship classes. Advance the development of the system to enable further applications, as follows: 1) Shore based military aircraft refueling operations, 2) Shipboard aircraft refueling (fixed wing, jet and helos), 3) Shipboard fueling of small boats and landing craft, 4) Ship fuel pump machinery rooms, collection of fumes incident to leaks, and 5) Ship paint and mixing rooms, collection of paint and solvent fumes.

COMMERCIAL POTENTIAL: This technology has commercial potential for seaport refueling operations, airport fueling operations, large scale liquid transfer operations at refineries and petrochemical plants in high air pollution areas, and hazardous spill cleanup operations.

N95-175 TITLE: Develop an Expendable, Gun-Launched Observation Vehicle

OBJECTIVE: Develop and produce an expendable payload-carrying observation vehicle and demonstrate flight after a 15,000-g launch acceleration and 7,000-g rebound deceleration typically experienced in launch from a 5' Naval gun.

DESCRIPTION: This SBIR topic seeks to develop an expendable, gun-launched, observation vehicle (OV). The OV shall be compatible with smooth barrel, tube-launched systems, such as mortars, and rifled systems, such as guns or howitzers, for bore sizes of 120 mm, 5 inches and 155 mm. Sabots or sleeves may be used to adapt the 120 mm OV to larger bore sizes. Regardless of bore size, the total handling length of the OV shall not exceed 30 inches with a total weight not to exceed 35 pounds in the 120 mm diameter configuration. The design of the OV and the materials used for its construction shall be optimized to maximize payload capacity and vehicle strength while minimizing parasitic weight and vehicle signature (audio, visual, RF and infrared).

The OV may the launched with or without rocket assist. The design of the base of the OV shall be adaptable to this form of propulsion and shall be capable of cleanly separating form this interface. The OV shall be fitted with a low drag nose shape and a self-starting, power plant which will sustain the vehicle in a loiter pattern at 10,000 feet altitude for a minimum of 3 hours. The power plant may be nose or tail mounted and shall provide a minimum of 100 watts of power continuously for the entire time of loiter.

The gun launched version of the OV shall utilize a government supplied control actuator system (CAS), inertial measurement unit (IMU), GPS receiver (GPS/Rx), two-way communication link (COM link) and sensor package (SP). The payload section of the OV shall contain the SP, COM link, GPS/Rx and IMU. It is highly desirable that the payload section be configure as one continuous volume which may also include the nose cavity, if not discarded. This section shall have a minimum volume of 120 cubic inches with a maximum load capacity of 10 pounds. Non shock-hardened (model grade), actuators and inertial sensors may be used for initial airframe tests which do not involve gun launch.

The nose of the OV may be discarded for the purposes of allowing forward-looking sensors a clear optical path or to permit the OV's power plant to function properly. The deployment of aerodynamic control and lifting surfaces shall be reliable and performed with as little disturbance to the OV's flight path as possible. Once all surfaces have been deployed, the OV shall possess adequate lateral and longitudinal (stick-free) stability so as not to require stability augmentation from an autopilot. The OV shall include a flight management system (FMS) containing all the software and hardware necessary to stabilize the airframe and navigate the OV, exclusive of the GPS/Rx and IMU. The FMS shall be capable of receiving and processing data from the government supplied GPS/Rx and IMU.

The OV shall be capable of reliable operation after the application of a 15,000 Gs set back acceleration pulse (8 ms wide) in line with the longitudinal axis. Lateral and set forward accelerations shall be 3,000 and 7,000 Gs, respectively. The unit production cost goal in quantities of 2,000 is $5,000, not including the control system.

PHASE I: (Concept Study): Phase I shall be final report describing theory of operation, estimated performance and the technical risks associated with the proposed design for phase II statement of work.

PHASE II: (Risk Reducing Hardware Demonstrations): The output of this program shall be hardware demonstrations including flight tests and other technical documents which verify the predicted performance. The Phase II test program shall include significant risk reducing demonstrations of the OV airframe and its components (hardware and software) through the gun launch environment.

PHASE III: (Form, Fit and Function): The anticipated Phase III effort will be the advanced development or engineering development phase of a naval surface fire support program to develop a gun launched, over-the-horizon targeting and battle damage assessment capability for the Navy or Marine Corp.

COMMERCIAL POTENTIAL: The potential of rugged, expendable aircraft is particularly valuable in fighting forest fires and emergency response to hazardous material accidents

N95-176 TITLE: Develop an Expendable Video Data Link

OBJECTIVE: Develop a small, rugged, data link (including antennas) to compress and transmit digital video signals from an expendable airborne observation vehicle to a Naval ship. Demonstrate operation after a 15,000-g acceleration adn 7,000-g rebound deceleration typically experienced in launch from a 5' Naval gun.

DESCRIPTION: A low cost data link is a key component of many sensor concepts to provide targeting for Naval Surface Fire Support. Unlike aircraft, UAV, or missile sensors, gun-fired sensors must be much lower cost and smaller, and their data links must be similarly small. Also, a key advantage of the gun is its fast response, and data links that require long setup periods are self-defeating.

The data link desired for this topic would be capable of being gun launched as part of an observation vehicle with a video camera sensor, and transmit this video back to the firing ship from a distance of 50–100 miles. The camera would be either a commercial-quality CCD imager (768x494 pixel, 24 bit color), or a lower resolution infrared imager. Two observation vehicles are under consideration: a parafoil with ten-minute mission time, and a winged vehicle with a three-hour mission time. Line of sight to the ship would be maintained with a gun-launched relay similar to the observation vehicle, without its sensor but with

room for a larger transmitter or more power. Only point-to-point operation on a dedicated channel is required—networking is not. Minimizing the cost of the expended projectile is the primary concern, even if the cost of the shipboard receiver is increased. The targets will be primarily tactical battlefield targets like artillery batteries, infantry positions, logistic sites, vehicles, and landing zones. The sensor must support single frames at full resolution but lower frame rate to support identification and battle damage assessment. A desirable capability would be to allow the operator to designate areas of interest that will be transmitted at higher quality with the background at lower quality. The observation vehicle will be equipped with GPS and an inertial navigator. The data link may make use of these components, for example, to provide timing and synchronization, or to assist in video compression by providing knowledge of camera motion.

Key to the design of this data link is the cost tradeoff between data compression and bandwidth. The contractor will make this tradeoff, keeping in mind the mission requirements. Neither the data link bandwidth or the compression technique is fixed. What is desired is effective tactical performance at minimum throwaway cost.

PHASE I: Define system requirements of resolution vs frame rate for the different mission functions (surveillance, reconnaissance, situational awareness, identification, targeting, and battle damage assessment). Establish targets for bandwidth, power consumption, volume and cost. Design the system, selecting compression techniques, data format, and RF signal characteristics.

PHASE II: Construct a prototype and a gun-launchable brassboard. (The contractor will have assistance from the government on gun-launch hardening of electronics) Demonstrate performance against field targets.

PHASE III: Transition would be to a gun-launched reconnaissance and targeting system being considered as a 1997 Advanced Technology Demonstration

COMMERCIAL POTENTIAL: In addition to the obvious commercial applications of mobile data systems, video teleconferencing, and mobile TV cameras, this system would be particularly useful for expendable sensors for fire fighting, hazardous materials accident response, land and sea rescue, and destructive testing.

REFERENCES:
1. Naval Surface Fire Support Study, J. G. Ferrebee, S. E. Anderson, and O. K. Blosser, Naval Surface Warfare Center, Dahlgren Division NWSCDD/TR-92/667, July 1992 provides more background on the operational concept, target set, and operating ranges.

WHY WE ARE PROPOSING THIS TOPIC: Targeting, identification, and battle damage assessment for Naval Surface Fire Support currently relies on non-organic assets such as satellite photography, manned reconnaissance aircraft, and intelligence reports. These assets are not controlled by the NSFS units, are not timely, and are not responsive to the changing battlefield environment. Responsiveness and flexibility are particular advantages of guns in fire support, and are key components of the Maneuver Warfare from the Sea operational concept.

Current data links that have the range needed are much too heavy. (For example, Unisys's Low Cost Interoperable Data Link, for the Short Range UAV, weighs 18 pounds.) However, there is great opportunity to capitalize on the recent advances in video compression and the emerging commercial RF components for the 2 GHz personal communications and wireless data markets.

N95-177 TITLE: <u>Development of Improved Methods for Removal of Conformal Coatings from Electronic Printed Circuit Boards</u>

OBJECTIVE: Develop and deliver easy to use equipment for the removal of conformal coatings from electronic printed circuit boards. This must be designed so as to be suitable for use in the extremely limited space available aboard surface ships and similar environments, and of minimal inherent hazards to personnel.

DESCRIPTION: Electronic printed circuit boards often have an epoxy or similar based coating which seals, covers and conforms to the imbedded or surface-mounted electronic components. Efforts to repair the circuit card by replacing components first requires removal of this conformal coating without damaging the other components of the card. Present methods involve the use of corrosive chemicals or micro-grinders, the substance and residue of which, respectively, poses serious personnel hazards. A new commercial process using micro-abrasive blasters can remove conformal coatings with relative safety but the equipment is far too bulky for use at repair stations aboard Navy ships, military field repair vans and in other locations where space is limited.

PHASE I: Identify the most promising techniques for conformal coating removal in the shipboard environment. Develop a prototype concept demonstration device and conduct tests to verify its capability to perform in the shipboard environ-

ment.

PHASE II: Refine the design of the prototype equipment and develop and deliver at least six fully operational systems suitable for an extensive evaluation by operating maintenance sites. At least two of these sites will be on board surface ships, and at least two at Navy Intermediate Maintenance Activities. Provide detailed technical data needed for training of technicians and for the logistic support of the equipment.

PHASE III: A Phase III effort is very probable. This would result in fully engineered equipment for widespread use at both military and private sector repair facilities.

COMMERCIAL POTENTIAL: Current commercial processes are either bulky or yield inherently hazardous risks. The conformal coating removal equipment developed would have a direct wide commercial application at a very large number of electronics repair facilities both in the U.S. and throughout the world. Other sites requiring electronic repairs using equipment suitable for confined locations, such as remote research sites, offshore oil rigs, or space stations, should be explored.

N95-178 TITLE: Develop Customized Training Using Artificial Intelligence Methods

OBJECTIVE: The development of a general purpose platform-transportable authoring system to produce customized training through the use of artificial intelligence procedures. The system should contain an artificial intelligence (AI) interface for student monitoring and its own or a commercial multimedia training program, and be transportable between a family of desktop CPUs.

DESCRIPTION: The Navy provides classroom training but generally lacks training facilities where Navy tasks are performed, e.g., aboard ship or in remote base stations. An innovative training system is sought which can be put on a personnel computer to provide customized training to sailors in performing specific tasks or functions. Artificial intelligence techniques will be used to customize lessons and act as an advisor to the student. The training tool will incorporate multimedia elements such as hypertext, graphics, audio and video. It should model the student and control the manner and level in which information is presented. It should monitor student progress and interactively modify the lesson to emphasize areas of difficulty. Alternatively, it should allow sailors to receive general on-line training in other topics of interest in accordance to their technician background and previous training. The artificial intelligence interface may be developed to work with existing multimedia authoring systems. A graphical user interface should be provided to allow the construction of courses by authors not having computer programming skills.

PHASE I: Investigate and report the requirements for a system meeting the above description and objectives. Design a solution and methodology for solving the problem, emphasizing the artificial intelligence technique, including the Artificial Intelligence interface for multimedia training. Use existing systems, which allow the AI components to be incorporated in a transparent manner, to provide the desired capabilities.

PHASE II: Develop, produce, demonstrate, and deliver a multimedia authoring tool for the creation of customized training. This system must run on a 386-based Personal Computer, and will facilitate the construction of courseware and training materials minimizing the programming skills required of the author. A small training problem will be selected by the Government and the Contractor, and will be implemented with the tool to demonstrate the desired capabilities.

PHASE III: Utilize the authoring tool in creating training courses for specific systems, devices, etc. The AEGIS Training Center would be one possible site. The other services may also use the tool.

COMMERCIAL POTENTIAL: The training products of this effort have broad applicability to the commercial sectors. In example, an on-line intelligent training system could benefit the automatize repair industry due to a wide variety of vehicles serviced. Refresher training produced by this tool can be used by any reasonably sized business to significantly reduce training costs.

REFERENCES:
1. "Multimedia goes on the Job Just in Time", pg. 39, New Media Magazine, July 1993.
2. "A Guide to Multimedia," by Victoria Rosenborg.
3. "Handbook of Artificial Intelligence", Avron Barr and Edward Feogembaun.

N95-179 TITLE: Develop a Unified Architecture for a Real-Time Distributed, Electronic Warfare (EW) Simulation

OBJECTIVE: Design and develop a distributed architecture using Object-Oriented Analysis and Design methodology for live, constructive and virtual Electronic Warfare simulations and visualization real-time data.

DESCRIPTION: Distributed simulation of Electronic Warfare scenarios entails excessive data traffic. Current distributed interactive simulations (DIS) message handling techniques are inadequate. An object-oriented design is needed to reduce the amount of traffic transmitted, transported, received and processed. The design should address the following topics:
(1) The mechanism for maintaining a consistent notion of time throughout a distributed, EW simulation;
(2) A unified, open architecture that will allow different, existing models to be combined seamlessly within the same simulation framework;
(3) Engineering considerations to achieve real-time simulation and visualization when transmission bandwidths and delays may be limited;
(4) Load management and "graceful" degradation of system performance as system saturation is approached.

PHASE I: Demonstration of feasibility of architecture
PHASE II: Delivery of architecture design with documentation
PHASE III: Produce system developed during Phase II

COMMERCIAL POTENTIAL: This activity would advance the technologies involved in the development of a standard interoperability framework. This is to say, it would research mechanisms for communication between unrelated software/hardware implementations. This would provide another capability in the reusable software components commercial industry.

N95-180 TITLE: Develop a Real-Time, Wave Propagation Model for Heterogeneous Clutter Scenes.

OBJECTIVE: Development of a radar wave propagation computer model for heterogeneous clutter scenes to be used in a real-time, distributed, Electronic Warfare computer simulation environment.

DESCRIPTION: Current algorithms for computing non-free space radar wave propagation loss are considerably more time-consuming when accounting for multipath-interference effects. Also, these models are limited to homogeneous clutter scenes. There exists a need for a model to be developed that will allow the user to abstract propagation effects such as atmospheric attenuation, multipath, refraction and diffraction into appropriated levels of detail when desired. The proposed radar wave propagation model should possess the following attributes: Capability to run in a real-time environment; ability to represent heterogeneous clutter scenes such as a land/sea interface or an archipelago (clutter may be represented either empirically or by spatial/temporal statistical distributions); provide for a rationalism to apply clutter models to real-word terrain data (e.g., Digitized Terrain Elevation Data).

PHASE I: Demonstration of feasibility of model
PHASE II: Delivery of computer model with documentation.
PHASE III: Produce system developed during Phase II for general applications

COMMERCIAL POTENTIAL: This activity falls within the context of the Modeling and Simulation community's push toward real-time capability in simulated environments. The type of environments simulated could range from tactical to theater warfare engagements, as well as, FAA air traffic training scenarios. Also, this activity would improve the performance correlation between the simulation and the real-world environments.

N95-181 TITLE: Surf Zone and Craft Landing Zone Obstacle Clearance.

OBJECTIVE: Develop concepts, equipment, and/or techniques to breach transit lanes through defensive (non-explosive) obstacle complexes located in the Surf Zone (0 - 10) and the Craft Landing Zone on the beach. This is a re-advertisement of Topic N94-202.

DESCRIPTION: Technologies may include any mix of explosive or non-explosive techniques. Concepts should emphasize high payoff for rapid obstacle clearance.

PHASE I: Develop and identify potential concepts, means of deployment and cost per system for obstacle breaching mission. Quantify capabilities of each concept.

PHASE II: Demonstrate optimum concept(s) from Phase I study, showing performance objective is achievable and capable of being deployed from existing fleet assets.

PHASE III: Execute full scale system design and build prototypes for developmental and operational test and evaluation. Demonstrate system readiness for initial operational capability by demonstrating acceptable performance, reliability,

maintenance, training procedures, and all other logistic support requirements.

COMMERCIAL POTENTIAL: Commercial applications include demolition, rapid debris clearance, site reclamation and support of rescue, mining, and construction operations. It could also be applicable to the reclamation of abandoned industrial, bridge, and wreck sites located in coastal areas.

N95-182 TITLE: Develop Aluminum Stabilization of NbTi Superconducting Wire

OBJECTIVE: To advance the development of methods to co-extrude aluminum as a stabilizer to super-conducting wires and thereby provide wires that can be used in military and commercial magnet systems, e.g., Magnetic Resonance Imaging systems and compact motors.

DESCRIPTION: Superconducting wire is made with a normal metal in intimate contact with the superconductor. The normal metal stabilizes the performance of the superconductor when it is used to make magnets. Copper has been the traditional choice for the stabilizer with the most common superconductor, NbTi. For various reasons, especially lightweight, aluminum is being developed as an alternative to copper. Pieces as long as 6,000' have been made of NbTi wire with an aluminum stabilizer. Many superconducting magnet applications require even longer pieces; however, current machine designs for the co-extrusion of aluminum are reaching their limits in terms of piece lengths. The Navy is interested in fostering the advanced development of machinery that can improve on this piece length.

PHASE I: In phase 1 the contractor will develop design plans for an aluminum co-extrusion machine. The machine will be capable of extruding aluminum onto copper clad superconducting core wires. The ratio of aluminum to the core wire can be as low as 2 to 1 or has high as 10 to 1. The diameter of the core wires can be as small a 0.3 mm and as large as 2 mm. The machine shall be capable of applying the aluminum in a continuous manner to pieces of core wire that can be as long as 100,000' and as short as 2,000'. The application of the aluminum shall not degrade the current carrying capabilities of the core wire.

PHASE II: In phase 2, the contractor will build the machine and use it to produce at least a 50,000' piece length of aluminum stabilized NbTi wire. The core wire shall have a diameter of 0.3 mm, and the ratio of aluminum to the core shall be 3 to 1. The core wire will be a mutifilamentary composite of NbTi filaments embedded in copper. The core wire shall be capable of carrying at least 200 amps at 5 tesla and 4.2 kelvin.

PHASE III: The contractor will also use the machine to produce a second piece of aluminum stabilized NbTi wire. The second piece shall be at least 25,000' in length. The core wire shall have a diameter of 0.8 mm, and the ratio of aluminum to the core shall be 3 to 1. The core wire will be a mutifilamentary composite of NbTi filaments embedded in copper. The core wire shall be capable of carrying at least 1000 amps at 5 tesla and 4.2 kelvin.

COMMERCIAL POTENTIAL: Supper-conducting wire is used to wind the magnets in Magnetic Resonance Imaging Systems (MRI). The wire presently used in MRI magnets requires that the system be cooled with liquid helium. This liquid needs periodic replenishment. Aluminum stabilized superconductors can eliminate the use of the liquid helium. Due to their lighter weight, magnets would with aluminum stabilized super-conducting wire can be conductively cooled with a cryocooler based (liquid helium free) refrigeration system. Eliminating the cost and availability constraints of liquid helium will make MRI systems less expensive and more available for worldwide use, even in remote locations. The design choices that will become part of the Navy's mine sweeping magnet system will become part of any conductively cooled commercial magnet system.

REFERENCES:
1. Superconducting wire is used to wind the magnets in Magnetic Resonance Imaging (MRI) systems. The present wire requires that the system be cooled with liquid helium. This liquid needs periodic replenishment. Aluminum stabilized superconductors have the potential to eliminate the use of the liquid helium. Due to their lighter weight, magnets wound with aluminum stabilized superconducting wire can be conductively cooled with a cryocooler based refrigeration system. Eliminating the cost and availability constraints of liquid helium will make MRI systems less expensive and more available for worldwide use, even in remote locations.

N95-183 TITLE: Design, Develop, and Demonstrate a Low Power Digital Signal Processing Multichip Module for Mine Warfare

OBJECTIVE: Demonstrate a multichip module architecture and technology that offers 50 to 500 million instructions per second

(MIPS) at a maximum power consumption of less than 10W. An improved Digital Signal Processor (DSP) is needed to support the high-rate digital signal processing required in the next generation mines that will require the processing of large amounts of acoustic array sensor data through complex algorithms.

DESCRIPTION: Mine development programs need considerable processing power but have limited space and power available. Multichip module technology is rapidly becoming available to meet these needs. In addition to the 100% duty cycle mode at less than 10W a light load mode (10% duty cycle), and idle mode (0% duty cycle, chip power on), and a sleep mode (0% duty cycle, everything off except a low speed clock) shall be available at appropriately reduced power consumption.
Module size should be less than five cubic inches. The ability to handle numerous analog and digital inputs is needed. Sixty four to 256 analog input channels with at least 10 bit resolution needs to be processed and 64 to 256 discrete. I/O bits are also needed. The basic I/O interface can be done on one module with I/O expansion done on another module. One or more RS232-C serial ports are required to support the system and code development. A real-time clock and two system clocks on the module are also required. Power can be 5.0 volts or 3.3 volts but only one supply is allowable. The DSP multichip module is aimed at tasks such as beamforming, high speed correlation and spectral analysis.

PHASE I: Design and develop a multichip module design for a high performance DSP for a mine system. Choose multichip module technology for fabrication.

PHASE II: Implementation of the Phase I multichip module design. Ten samples shall be constructed, debugged, tested and delivered along with complete software operating, development, debug packages with fabrication and software documentation.

PHASE III: Transition DSP to an upgraded mine or new mine development.

COMMERCIAL POTENTIAL: Small, high-performance DSPs are critical to the development of a large variety of commercial products. Large-scale production of low power DSP multichip modules will greatly enhance the equipment price/performance ratio and open new commercial markets for high performance, portable battery-powered equipment.

REFERENCES:

1. Multichip Modules, Johnson, Teng, Balde, IEEE Press.
2. 1993 Proceedings, International Conference on Multichip Modules, International Society for Hybrid Microelectronics.

N95-184 TITLE: Develop a Miniature, Low Power Ocean Bottom Seismometer/Accelerometer (S/A)

OBJECTIVE: Develop a low volume, low power, lightweight, low frequency (0.005-0.25 Hz) ocean bottom seismometer (OBS)/accelerometer for shallow water seismo-acoustic data collection.

DESCRIPTION: A Navy data collection system will need a miniature OBS to be deployed by aircraft in shallow seas. Important parameters are volume (<10 in^3), power (<2 mW), sensitivity (<1 nano-g $= 10^{-8}$ m/s^2), ruggedness, and cost.

PHASE I: Develop sensor design(s) to meet the required parameters. Evaluate design(s) and select most promising for fabrication. Project expected sensor performance of design(s). Concept must be eventually low cost and be able to withstand vibration and shock environments of aircraft delivery.

PHASE II: Fabricate, package, and test six (6) prototype sensors of each design. Evaluate design(s) for weapon incorporation with regard to required parameters. Prototypes should be suitable for field and environmental testing.

PHASE III: Transition prototype to 6.3 program for improved engineering design of data collection system.

COMMERCIAL POTENTIAL: An affordable miniature S/A will find wide commercial use in areas such as geological fault location, oil eploration, earthquake and volcanic warning systems, and nuclear monitoring. The fabrication technology use to build these miniature sensors lowers the cost and greatly improves the ruggedness of the sensor due to the very small size similar to the process of moving electronic circuits from printed circuit boards to integrated circuits.

REFERENCES:

1. "Measurements of Ambient SeaBed Seismic Levels Below 1.0 HZ on the Shallow Eastern U.S. Continental Shelf", Mark V. Trevorrow etal., J. Acoust. Soc. Am., December 1989, p. 2318-2327.

N95-185 TITLE: Develop a Miniature Magnetometer

OBJECTIVE: This program will research and develop a next generation or highly optimized Subgamma Micropower Miniature Magnetometer (SMMM).

DESCRIPTION: Existing sensors have performance limits that do not meet advanced undersea weapons requirements. This work will extend the state-of-the-art for magnetometers. Parameters are < .5mW. power consumption, noise < .1nT., eventual low cost of less than $50 per unit and production units capable of meeting weapon environmental specs.

PHASE I: Examine existing sensors for use in new technology. Develop and provide an innovative SMMM design and indicate its feasibility in laboratory tests or theoretical analysis.

PHASE II: Produce six prototype sensors, using the most promising technology as defined in Phase I. Performance parameters are to be optimized with low cost, and ruggedness considered secondary considerations at this time. Rigorous testing will be performed and the devices will be characterized for production and studied for ruggedization and production cost reduction.

PHASE III: Transition prototype SMMM to an upgraded or new undersea weapon development.

COMMERCIAL POTENTIAL: An advanced SMMM will open new commercial markets in the areas of vehicle surveillance, traffic road sensors, and new Intelligent Vehicle Highway Systems (IVHS) uses. Low cost magnetic sensors would also be used in manufacturing, security, and recycling.

REFERENCES:

1. Gordon, D.I., Brown, R. E., "Recent Advances in Fluxgate Magnetometry." IEEE Transactions on Magnetics, MAG-8, No.1, March 1972.
2. Lentz, J.E., "A Review of Magnetic Sensors", Proceedings of IEEE, Vol. 78, No. 6, June.

N95-186 TITLE: Develop and Produce a Large Screen Color LCD Projection System

OBJECTIVE: Develop and Produce a large screen color LCD compact projection system capable of producing clear, readable, presentations from vibrating platforms

DESCRIPTION: Conduct research to determine the feasibility, limitations and packaging considerations for a color, high resolution liquid crystal display (LCD) projection system that is relatively insensitive to vibration. The system should produce a clear, readable, crisp screen presentation when mounted to a platform that is vibrating. The technology used should be unlimited in its ability to vary the projection size with a nominal target size of 21" to 27" diagonals. The system should provide SVGA graphic quality resolution with consideration given to HDTV as a future application. Economical implementation is an important consideration; therefore, use of off-the-shelf components wherever possible is strongly encouraged. The packaging concept should be the smallest possible depth to permit installation in compact locations.

PHASE I: Develop a large screen color display design, and determine the feasibility of projecting color LCDs onto a variable screen size. Determine the limitations of the technology with respect to resolution, projection elements size, (i.e., LCD size), packaging compactness, particularly depth, and screen blur or jitter due to vibration. Demonstrate the limitations via simple graphics, text and television projections

PHASE II: 1) Build a prototype system using the design(s) proposed in Phase I. 2) Test the prototype to determine its ability to withstand vibration and present a clear, defined, sharp color image. 3) Test the prototype to verify that no resonant frequencies exist in the range from 0 to 25 Hz. 4) Test the prototype to verify that the system electronics are not susceptible to electromagnetic interference (including susceptibility to DC magnetic fields up to 20 Oersteds), are compatible with typical industrial power (115 VAC preferable), does not radiate unsafe electromagnetic emissions in accordance with FCC standards, and does not experience high failure probability due to temperatures between 20 degrees F to 130 degrees F.

PHASE III: Build a production system for installation onboard the New Attack Submarine for use in the ship control station. 1) Prepare level III drawings for the system. 2) Fabricate a cabinet housing three LCD projection systems to fit in a maximum footprint of 96 inches wide by 44 inches deep and 58 inches high. 3) Test the production unit to ensure it has no resonant frequencies from 0 to 25 hz, that it can operate reliably in temperatures from 20 degrees F to 130 degrees F, that it passes EMI per MIL-STD-461, that it survives shock amplitudes of 10Gs, and that it is compatible with shipboard type I power as defined in MIL-STD-1399.

COMMERCIAL POTENTIAL: This technology has the potential to become the next generation movie theater projection system

and the next generation home television, particularly for HDTV and the information superhighway. The LCD element can be projected onto varying screen sizes with controlled loss of resolution to reduce the cost of the overall system dramatically, making a projection screen color television affordable to the average American and drastically reducing the cost of expensive movie theater projectors while simultaneously making them compatible with other media planned for the information superhighway.

REFERENCES:
1. FCC standards
2. MIL-STD-461
3. MIL-STD-1399

N95-187 TITLE: Develop a Miniature Diode Laser Velocity Sensor

OBJECTIVE: Develop and produce two-component backscatter miniature Laser Doppler Velocimetry (LDV) probes utilizing commercially available visible laser diodes, avalanche photodiodes, and miniature optical components. The size and power requirement of these probes will allow LDV to be used on small, autonomous, battery-powered Navy test vehicles.

DESCRIPTION: The LDV measurement technique has unique characteristics including it's non-intrusiveness, fast response, and high accuracy. However, the size, power requirement, complexity, or cost or standard LDV measurement systems often makes them impractical for many fluid velocity measurement tasks. Replacing ion gas lasers and photomultipliers with visible diode lasers and avalanche photodiodes results in a significant cost and an even greater electrical power and component size reduction. Several important LDV applications for Navy research are on hold until a small low power LDV prove can be developed. These applications include but are not limited to: 1) propeller inflow measurements on maneuvering, battery powered research vehicles, and 2) time series measurements of flow seen by an individual propeller blade, whereby the effects of wake unsteadiness on propeller performance are measurable.

PHASE I: Develop components and design alternatives for a two-component backscatter diode laser velocimetry probe. Produce six waterproof working prototype probes for evaluation by the Navy. The diameter and the overlength of the entire miniature LDV probe (including two transmitters and their receivers) for the two diode lasers must not be larger than 25 mm and 200 mm respectively.

PHASE II: Explore techniques to add laser beam frequency shifting or its equivalent to the diode laser based sensor developed in Phase I and to add a family of miniature LDV probes with various sizes, frequency, power, and focal lengths.

PHASE III: Refine manufacturing techniques to increase robustness of the probes and to lower instrument costs. Produce and sell a commercial product that can be used with available LDV signal processors and software from other LDV equipment manufacturers.

COMMERCIAL POTENTIAL: LDV instrumentation is currently a good business for several instrumentation manufacturers. Small, low power, probes with completely self contained optics would open up many new application areas for LDV. There has been quick adoption (over the past 5 years) of fiber optic links between large high powered optics systems and small rugged probe sensors. This shows that the instrumentation market is looking for ways to simplify and miniaturize the LDV technique. The diode laser and avalanche photodiode based system envisioned would enclose the entire optics system inside a rugged, waterproof probe as small as fiber optic LDV probes. The component costs of a diode laser probe compare favorably to the ion gas laser, photomultipliers, and fiber optics of conventional LDV systems.

REFERENCES:
1. Coughran, M. and D. Fry, "Expected Capability of Multiple - Probe LDV Propulsor Inflow Measuring System", CDRKNSWC/HD-1308-01, Feb. 1990. ADA220778

N95-188 TITLE: Develop Stealthy Materials for Moving Systems in the Sail of Submarines

OBJECTIVE: Develop and provide stealthy, quiet, low observable structural materials for applications to masts, housings and sensors used for optical, ESM, and communication purposes.

DESCRIPTION: Current submarine planning places great emphasis on stealth. Moving parts in submarine sail systems can be a significant contributor to ship radiated noise. It is believed that the creaking, grinding, slipping, galling, clanging, sliding

noises produced by raising, lowering and rotating mast systems can be greatly reduced through the use of high damping structural plastics incorporating low observable features. Structural plastics have the potential for adequate combat readiness with quiet, low observable characteristics.

PHASE I: The contractor will: 1) Conduct a review study of structural plastic candidates compatible with the requirement for quiet, low observable capability; 2) Using structural plastics, manufacture test specimens for mechanical property testing, noise testing and radar return testing; 3) Conduct mechanical property tests, noise tests, and radar return tests.

PHASE II: The contractor will: 1) Continue Phase I efforts to determine the best materials for full scale exploitation; 2) Using the best material, the contractor will design, manufacture, and provide to the government, for testing, a developmental Type 8 MOD 3 outer-head housing and upper section of mast and a developmental Integrated Electronic Mast/Above Deck Sensor Unit (IEM/ADSU) housing and upper section of mast and adapter; 3) Using the materials of 2) above, manufacture, test specimens for mechanical property testing, noise testing, and radar return testing; 4) Conduct mechanical property, noise and radar return tests on the materials of 3 above; 5) Conduct RCS tests on the Type 8 MOD 3 outer head housing and upper section of mast and on the IEM/ADSU housing and upper section of mast.

PHASE III: Using the results of Phase I and II, the contractor will: 1) Further define candidate materials for limited production; 2) Conduct analysis and planning in support of limited production of IEM/ADSU and Type 8 MOD 3 units; and 3) Manufacture four (4) each of the production type IEM/ADSU and Type 8 MOD 3 units for contractor and government testing, installation and evaluation.

COMMERCIAL POTENTIAL: The automotive, aircraft and plastic/elastomer industries could benefit from this effort, providing superior cabin and interior environments with reduced ambient noise and longer working lifetimes.

N95-189 TITLE: Development of Manufacturing and Assembly Methods for the Production of Acrylic/Fused Silica, Laminated, Composite, Heated Periscope Head Windows

OBJECTIVE: Develop and provide structurally adequate Naval periscope headwindows which will be compatible with underwater explosion survivability requirements.

DESCRIPTION: The proposed effort to develop and manufacture acrylic/fused silica, laminated composite, heated periscope head windows using electro-conductive coating heating to harden the head/head window region of the periscope, will prevent periscope flooding and thereby increase the periscope underwater explosion resistance and survivability.

PHASE I: The contractor will perform assessment and evaluation studies of approaches for the manufacturing of acrylic/fused silica, laminated, composite, heated periscope head windows using electro-conductive coating heating. Develop and identify the manufacturing and assembly methods suitable for structurally adequate periscope head windows. Perform structural and thermal analysis to support the various alternate approaches. Develop engineer drawings of those approaches which offer the greatest potential for Phase II development. Deliver bi-monthly letter type progress reports and a detailed final technical report covering all work performed in Phase I including analysis, drawings and sketches, study results, conclusions and recommendations.

PHASE II: Develop and provide ten (10) developmental acrylic/fused silica, laminated composite, heated periscope head windows for test and evaluation. Provide complete manufacturing technical report covering all Phase II effort including test procedures, test results, analysis, manufacturing and assembly methods, study results, drawings and sketches, conclusions and recommendations.

PHASE III: Using the results of Phase I and II, the contractor will: 1) further define materials and processes compatible with limited production; 2) conduct analysis and planning in support of limited production; 3) manufacture and provide ten (10) prototype acrylic/fused silica, laminated composite, heated periscope head windows using electro-conductive coating heating for contractor and government testing, installation and evaluation.

COMMERCIAL POTENTIAL: The optical automotive and aircraft industries will benefit from this innovation through very rigid and dimensionally stable large-scale optical materials (to improve chassis and airframe stiffness despite large window are) and processes that are applicable to practical optical problems related to fogging, icing, and visibility in both automotive and aircraft.

N95-190 TITLE: Develop and Produce New Elastomeric/Plastic Foam Materials for Shock Wave Attenuation

OBJECTIVE: Develop materials, formulations, and processes for producing new, unique shock wave attenuating materials

which are designed to utilize both shock wave reflection and energy absorption mechanisms.

DESCRIPTION: There is a need for improved shock wave attenuating foam (SWAF) materials to provide increased underwater explosion (UNDEX) survivability of vulnerable, wet components and systems. The proposed effort will extend current SWAF technology by incorporating both shock wave reflection and energy absorbing mechanisms such as to produce SWAF materials with improved attenuation properties leading to decreased volumetric requirements and potentially decreased costs.

PHASE I: Formulate develop, and manufacture SWAF specimens incorporating new concepts and new fiber and matrix materials which offer potential for increased shock wave attenuation through both reflection and energy absorption mechanisms. Compression and sound speed tests will be conducted.

PHASE II: Using the concepts, approaches, processes and materials offering the greatest overall potential for Naval SWAF applications proposed in phase I, focus on (1) formulating and processing for quantity production and quantities of SWAF panels (12" x 12" x 2" and 30" x 30" x 2") as needed for sound speed, compression and UNDEX testing. UNDEX tests will be conducted on those concepts and materials offering the greatest overall potential for Naval SWAF applications.

PHASE III: Using the results of Phase I and II, the contractor will: 1) further define and finalize candidate materials suitable for limited production; 2) conduct analysis and planning in support of limited production of a candidate material which is acceptable for both technical and production viewpoints; and 3) manufacture ten (10) sets of shock wave attenuating foam for contractor and government testing, installation, and evaluation.

COMMERCIAL POTENTIAL: The plastic/elastomer, shock and sound industries will benefit from this innovation.

N95-191 TITLE: Connection of Simulation Based Design (SBD) and Advanced Distributed Simulations (ADS) for Military System Development

OBJECTIVE: To enhance Simulation Based Designs (SBD) by building an executable representation of a numeric model to conform to the protocols for execution in Advanced Distributed Simulations (ADS). The goal is the ability to use SBD output as ADS input and vise-versa.

DESCRIPTION: SBD has been shown to provide cost savings in the development of large military systems through the early detection and resolution of problems that require prototypes or mock-ups to visualize. The key advantages are using information at the earliest possible opportunity to visualize the system, and collection of information from all domains into a coherent system model. For instance, knowledge of the landing characteristics of a given aircraft intended to be housed on a given surface vessel may be used to avoid costly miscalculations in hangar door size or light placement, even if both the aircraft and the surface vessel are still on the "drawing board". Executable computer models of each system can be created to ensure that the dynamics of one do not interfere with the other.

In another area of technology, ADS is being used to provide cost savings in acquisition and enhanced fidelity of experimentation, test and evaluation and training. These simulations are carried out via various distributed networks available allowing the integrated exercise of executable models, databases, prototypes and mock-ups and hardware-in-the-loop (HWIL) without relocating all of the elements involved to one central site or substituting improper or inconsistent modules. In order to execute all of the models as if they were a part of the same system, certain protocols must be embedded within the models which accept, interpret and act upon messages according to the behavior of the system represented. These models must also emit messages which indicate the response of the modeled system to its stimuli.

Models built with SBD are highly integrated with the parts and domains of the system under development, but are rarely compatible with the models used in ADS. That is to say, if they exist, SBD models lack the structure and protocols necessary to respond to messages defined for such simulations. This is unfortunate, since it represents a disconnect of the type that both technologies are hoping to avoid; providing access to design information as soon as it is known in order to evaluate the total design. Reasons include the fact that the SBD model is usually a "work-in-progress", while the ADS model is static; the tools for SBD are not developed with ADS in mind; and certain required characteristics of an ADS model are not necessary in an SBD model (e.g. real-time response).

What is needed is a technique for the automatic translation or enhancement of an existing SBD model or construction of such a model if none exists to conform to protocols for execution in an ADS exercise. This would provide two benefits. First, once a particular design has reached a stable configuration, it would allow developers of other related systems to assess the impact of design decisions made in its development. Second, it would allow the designers to assess the impact of critical changes to the design using the very latest and highest fidelity external data from models or fielded systems.

PHASE I: Development of the technique for the enhancement of SBD models which comply to protocols for ADS. This would include a characterization of SBD model types, an analysis of ADS protocol for each type, and a technique for the

conversion of the SBD model to one suitable for ADS usage. Apply the techniques to a simple system design.

PHASE II: Produce a prototype tool which would automate the Phase I techniques. The tool would include the possibility of use and input to the SBD-ADS translation with the intent of responding to the specific needs of the simulation. Demonstrate tool on an example SBD model.

PHASE III: A Phase III effort would produce a commercial quality tool which accepts models of various types and levels of fidelity, which allows the user to tailor the transformation to suit particular needs and which operates efficiently so that the model is produced and can be exercised in such a way that simulation results are enhanced by the SBD changes to the ADS demonstration.

COMMERCIAL POTENTIAL: The computer tool developed to aid in the design, test, and evaluation of military systems can also be used for commercial systems. Examples are computer-embedded systems for transportation communications and air traffic control.

N95-192 TITLE: Develop Mechanical and Environmental Test Procedures for Transmit/Receive (T/R) Modules Procedure

OBJECTIVE: To develop mechanical and environmental test procedures for transmit/receive (T/R)modules.

DESCRIPTION: The use of phased arrays in radar and communications applications improves reliability of the system by removing several high failure rate items from the system. However the phased array itself is made up of numerous elements that must meet reliability requirements. Active arrays are made up of numerous active transmit/receive (T/R) modules, each incorporating amplifiers and antenna elements. Mechanical and environmental test data for T/R modules is required to establish their suitability for active array applications. Mechanical and environmental test procedures will be developed for use as reliability prediction tools.

PHASE I: The contractor shall investigate the design and construction of T/R modules and determine possible failure mechanisms. A test methodology shall be developed for mechanical and environmental testing that will stress the module to simulate actual use with consideration of the identified failure mechanisms. The test methodology shall incorporate optimized tests that will stress the module without undue expense or test complexity The test methods developed shall be documented in procedures.

PHASE II: The contractor shall perform mechanical and environmental testing on a small sample of available T/R modules following the procedures developed during phase I. Improvements to the procedures shall be identified based on test results.

PHASE III: Implement the test procedures across all T/R module developments.

COMMERCIAL POTENTIAL: Optimized environmental and mechanical test procedures will benefit commercial T/R module manufacturers since it will help them improve module reliability by indicating failure mechanisms triggered by environmental and mechanical stresses. Synthetic aperture technology has already been use in nonmilitary applications such as radar terrain mapping, and can expect much wider use in commercial radar when the technology problems are resolved. T/R modules eliminate the need for microwave tubes and wave-guides, and can improve reliability and performance.

N95-193 TITLE: Optimal Active Array Architectures for Communications Applications

OBJECTIVE: Identify and develop active array architectures which provide an optimal combination of characteristics in communications system applications in the areas of: (1) low cost, (2) low bit error rate and array low sidelobe performance, (3) reduced weight and complexity, and (4) graceful degradation.

DESCRIPTION: Solid state elements have the potential for providing lower cost, lighter phased array systems. However, better insight into overall architectures for employing these devices is currently needed. Detailed system engineering studies shall be performed to identify optimal active array architectures. Specific areas to be studies may include the RF distribution system, distribution of taper commands and prime power, air and liquid cooling approaches, the number transmit/receive (T/R) modules to power supply modules and their spatial distribution in the aperture, and periodic operational calibration techniques and their impact on architecture. The impact of emerging technologies, such as photonics, may be investigated to determine how they can best be exploited in terms of the array architecture (e.g. RF distribution and time delay beam steering). This investigation shall screen out architectures which are not feasible and shall develop preliminary performance requirements at the T/R module and

subarray level for the most feasible architectures such that experimental architectures can be built and tested at the subarray (or column) level. Additionally, the design architectures or communication system active arrays under development, such as CEC and Iridium, should be reviewed (if possible) to identify areas of potential optimization, particularly those which will reduce cost.

PHASE I: Identify candidate optimal architectures and perform initial top level systems engineering studies to rank the architectures from most feasible to least feasible. Select at least three architectures far a detailed evaluation in Phase II and develop a detailed evaluation plan for phase II.

PHASE II: Perform detailed performance and cost analyses of the candidate optimal architectures selected in phase I. Develop detailed T/R module and subarray requirements for the two most promising candidates and build and test these designs. Develop cost feasibility projections for commercial applications.

PHASE III: Develop a low cost producible design(s) for the optimal architecture(s) based on the evaluation of phase II. Areas to be addressed are component reliability, performance margins, and improvements to manufacturing processes. There are a large number of potential commercial applications in the wireless communications arena, ground stations, VSATs, and point-to-point mobile communications. The potential markets are the broadcast industry (TV, cable, DES, etc.), law enforcement voice/data communications, and the growing mobile cellular, spread spectrum, and satellite personal and voice data communications. Phase III will address a need in one of these commercial areas/markets.

COMMERCIAL POTENTIAL: Active arrays for commercial use that are low in cost will be widely accepted for commercial communications and radar systems. Synthetic aperture technology has already been use in nonmilitary applications such as radar terrain mapping, and can expect much wider use in commercial radar when the technology problems are resolved.

N95-194 TITLE: Develop a Channelized Direction Finder

OBJECTIVE: The objective of the Channelized Direction Finder is to provide key device technology needed for performing precision angle of arrival measurements in wide instantaneous bandwidth environments with simultaneous, copulse, emissions.

DESCRIPTION: The proliferation of high duty cycle radar signals in the radar spectrum results in multiple radar transmissions at the target platform. To accurately assess the threat environment the individual transmissions need be independently measured. Signal parameters are measured using channelization techniques. The Channelized Direction Finder program extends the Channelization function to the measurement of signals' angle of arrival.

PHASE I: The contractor will perform a feasibility analysis, establishing a practical approach for implementing the system processing function and will provide technology developments and demonstrations necessary to this effort, including a 'roadmap' of the feasibility efforts, developments, and demonstrations. The feasibility analysis will consider the range of signal conditions in which the sensor must operate. The constraints on the contractor's approach will be established and the critical development areas in the approach will be defined.

PHASE II: Critical technologies and device developments will be addressed during this phase to show performance progressions necessary in operational equipment. A demonstration of the proposed approach will be provided based upon the feasibility analysis conducted in PHASE I. Both laboratory and shipboard demonstrations will be performed to verify the contractor's approach.

PHASE III: Development of the Channelized Direction Finder model will be implemented for shipboard engineering tests with the ESM-ATD. Antenna and processor interfaces for the ESM-ATD will be provided by the contractor and the contractor will support system integration. Successful development will form the basis for incorporation into IEWS.

COMMERCIAL POTENTIAL: Air Traffic Control, Navigational Aid

REFERENCES:
1. Levitt, H.L., Alexander, E.M., Fine, T.A., TSE, A.Y., Spezio, A.E.; ousto-Optic Precision Direction Finding System; S.P.I.E. Vol. 1958, September 1993.
2. Spezio, A.E., Lee, J., Anderson, G.W.; Acousto-Optics for Systems Applications; Microwave Journal, February, 1985.

N95-195 TITLE: Development of an Automated Logistics Software to Implement Hardware Change Control and Parts Control from Problem/Failure Reports of the Cooperative Engagement Capability (CEC) Program.

OBJECTIVE: Develop a software program using DBase, Foxpro, Excel or similar software that will take information from Problem/ Failure Report Data and automatically revise hardware serialized configuration of the system to the Lowest Replaceable Unit (LRU) and update spare part availability status from 610 test sites.

DESCRIPTION: The Automated Change Control and Parts Control Software Program is envisioned to be a labor saving, cost effective way to provide logistic coordinators and configuration management personnel accurate realtime data on the status of actual configuration of military hardware and the spares available to support these configurations in case of equipment breakdowns.

PHASE I: The contractor shall research existing user software and establish contacts within the organization. The contractor shall determine the appropriate hardware and software tools by performing an initial user study, and following the recommendations of CEC Program contacts. The product of Phase I shall be a report that list the necessary software and hardware, and fully describes the user interface process and intended approach for software development.

PHASE II: Upon successful completion of Phase I, the contractor shall generate the software program and test the program in a simulated user environment. The skill level of users shall be equivalent to test and support personnel skills conducting military
equipment testing.

PHASE III: The contractor shall provide a marketable software program detailing the necessary hardware and software required along with a handbook detailing the user requirements and procedure to fully utilize the program. By providing a generic program, the software can enhance existing systems and reduce the amount of manual key entry in data bases at commercial enterprises. Complimentary information will be revised automatically and simultaneously.

COMMERCIAL POTENTIAL: An inexpensive labor saving and reliable software tool that automatically revises data for use by logistic and product support personnel. This software will appeal to virtually any commercial enterprise involved in maintaining records of special equipment such as a fleet of cars or records of part replacement on products sold to customers and maintained by the product manufacturer/distributor tie., Heating Ventilation Air Conditioning (HVAC) Systems or Industrial Equipment. This off the shelf software should be especially useful to small businesses that cannot afford the large capital expenditure for configuration and inventory control.

N95-196 TITLE: Develop a Lightweight Electronic Equipment Enclosure

OBJECTIVE: Develop a lightweight, low cost, electronics equipment enclosure suitable for use in a military shipboard environment.

DESCRIPTION: The Navy is currently imposing a weight limit on the Cooperative Engagement (CEC) System. Since a significant portion of the electronics is purchased, and the power control hardware of necessity contains a great deal of copper, the next likely candidate for weight reduction is the enclosure. This is especially true given that standard enclosures now in use are heavy and expensive to produce. A lightweight enclosure built to fully hardened (non-nuclear) requirements for ship internal electronics equipment is desired. The CEC System requires that this enclosure be configured to house and remove heat from up to 186 6" X 9" "double eurocard" convection cooled circuit cards, their associated power supplies and conditioners, and electronics controls.

Such an enclosure could provide a model for future enclosures in Navy systems as electronics continue to shrink and new ships are built smaller and lighter.

PHASE I: Develop initial drawings of the enclosure. Provide a report on the development of the enclosure including such considerations as alternate materials, possibly composites. Address concerns of EMI/EMC shielding, shock, and vibration compatible with a shipboard military environment.

PHASE II: Develop and deliver a Level III drawing package suitable for production of the enclosure.

PHASE III: Manufacture full scale prototypes for environmental, shock, vibration, EMI, and other tests. Participate in testing and additional design efforts in order to produce a useable final design.

COMMERCIAL POTENTIAL: Technology from the development of lightweight, low cost, producible enclosures may be transferrable to the aviation and automotive industries. Lightweight is a highly desirable feature of equipment in the

transportation sector where the economics of fuel consumption are paramount. As more sophisticated electronics makes its way into commercial transportation there will be a need for lightweight, low cost environmentally rugged methods to package those systems.

REFERENCES:
1. MIL-STD 2036

N95-197 TITLE: Chemistry of Self Propagating High Temperature Synthesis (SHS) Particle Clouds in Air

OBJECTIVE: Develop dispersion and ignition of SHS particle clouds in air and measure reaction rates and energy release.

DESCRIPTION: Technology has been developed to prepare SHS particles with metal to metal or metal to carbon systems. Of particular interest to the Navy is the dispersion of these particles in air to form clouds with subsequent chemical reactions.

PHASE I: Research should focus on proving the ability to inject and form SHS particle clouds in the air. The effort should demonstrate an understanding of ignition conditions, propagation conditions, and be able to measure the chemical reaction rates.

PHASE II: Develop those techniques formulated in Phase I to disperse and ignite the SHS particles with measurement of chemical reaction rates. Experimental conditions such as dispersion conditions type of particles (metal/metal or metal/carbon systems) particle size, morphology, compaction of original bed (porosity) and enhancing ingredients should be systematically studied and related to chemical reaction rates.

PHASE III: Military applications from this technology will transition into the Projectile Technology Program.

COMMERCIAL POTENTIAL: Industries that need to understand accidents involving explosions of particles in the air (i.e. coal mines, flour mills, metal powder factories) would benefit from this technology. The U. S. Bureau of Mines, Pittsburgh Research Center Fires and Explosions Office has expressed interest in assisting Phase II awardees in preparing the process for further development in Phase III.

REFERENCES:
1. J. E. Gatica and V. Hiavacek, "Laboratory for Ceramic and Reaction Engineering", Ceramic Bulletin, Vol 69, No. 8, 1990

N95-198 TITLE: Prompt Formation of Metallic Vapor Clouds

OBJECTIVE: Demonstrate ability to simultaneously generate metal vapor clouds from Self Propagating High Temperature Synthesis (SHS) reactor beds.

DESCRIPTION: A combustion synthesis utilizing metal/metal and metal/carbon reactor beds are well documented in the open literature. Reaction rates are proportional to particle size, morphology, compaction (porosity), and rate of bulk heating. The proposed new technology would combine SHS reactor bed technology with the ability to simultaneously vaporize metal from the large heat fluxes.

PHASE I: Demonstrate feasibility to prepare SHS reactor beds containing metals to be vaporized. Determine the basic combustion characteristics, mass balance, metal vapor, and heat evolved.

PHASE II: Develop the experimental SHS techniques for optimization of metal cloud formation and cloud modeling. Demonstrate the understanding of the process for sample preparation and physical property characterization. Expand characterization of composition preparation and combustion conditions. Develop methods of prompt initiation of reactor beds and formation of metal vapor. Demonstrate the relative importance and applications of metal vapor oxidation versus non-oxidation deposition (plating). Deliver prototype reactor bed that simultaneously develop metal vapor clouds for military application.

PHASE III: Military applications that would benefit from this technology are reactor linings, heat shields, and numerous metallurgical products. This technology should transition into the Projectile Technology Program.

COMMERCIAL POTENTIAL: Industries that need new reaction engineered materials for high temperature and/or erosive environments such as reactor linings, heat shields and new metallurgical applications can benefit from this technology.

REFERENCES:

1. J. E. Gatica and V. Hiavacek, "Laboratory for Ceramic and Reaction Engineering", Ceramic Bulletin, Vol 69, No. 8, 1990; "Aluminum Vapor Release in the Atmosphere", RAD-TR-76-221, 1976. ADA028060

N95-199 TITLE: Data Compression Techniques on Microwave Link

OBJECTIVE: Explore possible data compression techniques to shorten transmission time, reduce transmission power levels, or improve data throughput of microwave spread spectrum jam resistant communications links.

DESCRIPTION: The Navy is developing a communications network to allow ships to share air defense radar and fire control data among a battle group. The program is termed the Cooperative Engagement Capability (CEC). One of the key technology areas of the program is the communications link between ships. This is done using jam resistant encrypted communications on microwave (Cband) links. Current problems in these links are: the power required to meet operational specifications (and hence the size and weight of the CEC system) is higher than desired and the data throughput of the links is not as high as desired.

PHASE I: The contractor shall research possible data compression techniques that are compatible with the encryption scheme employed and present a tradeoff analysis of the techniques (either software, hardware or a combination of the two).

PHASE II: Upon acceptable results of phase I, the contractor shall develop a test system for application on a CEC unit during operational testing.

PHASE III: Development of a component or module along with requisite software for production CEC systems which can be transitioned to very high data rate transmission for use in cellular, satellite, or broadcast communications.

COMMERCIAL POTENTIAL: The data compression technique developed will also be useful for other microwave link applications, such as landbased communication repeaters, or satellite communications. Data compression techniques for microwave communication have direct application to commercial communications technology, particularly in the field of satellite communication. This technology would allow greater capacity in present and future communications satellites.

N95-200 TITLE: Development of Rapid Prototyping of Application Specific Signal Processors (RASSP) Program Interface for the Cooperative Engagement Capability (CEC) Program

OBJECTIVE: Develop an interface to the RASSP program toolset to allow the CEC program development team access designed development tools in support of the processor designs used by the CEC program.

DESCRIPTION: The RASSP program is envisioned as being a large networked development environment for electronic products. Current activity has just begun to establish the tools that will be made available inside the RASSP design environment (RDE). The RDE will offer the user the ability to access and use a suite of design, development, test and simulation tools to rapidly design and debug a new electronic product without the need to purchase a lot of expensive computer-based design tools. It is the development of an interface to the RDE that is the objective of this SBIR topic.

PHASE I: The contractor shall research the developments of the RASSP RDE and establish contacts within the organization. The contractor shall select the appropriate hardware and software tools by performing an initial concept study, and following there commendations of RASSP RDE contacts. The product of phase I shall be a report that lists the necessary software and hardware, and fully describes the user interface process.

PHASE II: Upon successful completion of phase I, the contractor shall establish a RASSP RDE interface system, and perform initial design of a CEC product (to be determined prior to award of phase II) using the RDE.

PHASE III: The contractor shall develop a marketable interface product consisting of the necessary hardware and software, along with a handbook detailing the user requirements and procedures to fully utilize the RDE.

COMMERCIAL POTENTIAL: An inexpensive alternative to expensive tools for the design of complex electronic components, modules, and systems will appeal to virtually any commercial enterprise, and especially small business that cannot afford the large capital expenditure of a dedicated design tool suite. Also the standardization of the design interface will save redundant efforts on future designs. Application specific signal processors have direct application to commercial communications and radar technology.

N95-201 TITLE: Shared Aperture Concepts for Point-to-Point Communications

OBJECTIVE: Maximize the utilization of ship and airborne equipment by sharing aperture, transmitter, and processors between communications, radar, and possibly EW tasks.

DESCRIPTION: The Navy is seeking methods to achieve reductions in the overall size, weight, and cost of equipments on combatant ship and aircraft by sharing common subsystems among different functions. For example, on AEGIS ships, three of four arrays are idle at any given time. The idle arrays could be used to provide enhanced communications with other ships or aircraft using pencil beams via a secure wideband data link. This will replace other equipment performing a similar function. These, and other shared aperture techniques using active array technology, promise to reduce overall system costs compared to the use of separate equipment.

PHASE I: Determine the requirements for secure fleet communications and examine concepts for meeting these requirements using shared aperture/transmission equipment. Examine both near-term concepts using existing arrays and equipment, and far-term concepts using active array approaches. Perform a preliminary assessment and recommend candidate concepts for detailed analysis in phase II.

PHASE II: Perform a detailed analysis on the concepts identified in Phase I. Assess performance and identify potential cost savings and compromises resulting from the shared aperture concept. Prepare plan for development and demonstration of promising approaches. Develop a performance simulation and techniques for configuring and reconfiguring the sensor and communication modes in real time. Develop, demonstrate, and evaluate a scaled breadboard system that can perform radar, communications, and possibly electronic warfare functions.

PHASE III: Develop the system for use in current Navy radar or communications systems. Proceed with the commercial introduction of the system developed under phase II into the commercial airlines and air freight markets since these are large volume markets which can further reduce costs through economies of scale.

COMMERCIAL POTENTIAL: Similar gains in shared equipment will be realized by commercial communications and radar systems aboard merchant vessels. Commercial ground based and mobile communication systems may also benefit by using the equipment sharing approaches developed by this study.

N95-202 TITLE: Integrated Tester Software Diagnostics

OBJECTIVE: To improve upon currently available automated diagnostic totals by developing a total suite consisting of next generation diagnostic algorithms and a tester simulation environment.

DESCRIPTION: The Navy currently uses CASS (Consolidated Automated Support System) board testers to perform diagnostic tests on complex electronic modules. The diagnostic test development is a time consuming process involving several CASS tools and use of the tester itself. Once the diagnostic test is developed it must be tested by manually inserting faults on a device under test (DUT) and verifying that the diagnostic test finds the expected fault. In order to validate a diagnostic test program with some efficiency, only a small fraction of possible faults are actually inserted and verified for detection by the diagnostic test program. A new tool that can simulate a tester in software, and be integrated in the test development environment, will save the expense of using the tester for diagnostic program validation and lengthy software troubleshooting. This tool will also allow far more faults to be verified as detectable without tying up valuable tester resources.

PHASE I: The contractor shall research the requirements for simulation of the tester in software, and develop a fundamental approach for the creation of an integrated diagnostic tool that allows for fault verification in an integrated test software environment. The contractor shall also investigate development of improved diagnostic algorithms that may shorten the development time or improve the performance of fault diagnostic programs.

PHASE II: Upon the successful completion of phase I, the contractor shall develop the CASS simulation environment and integrate this with improved diagnostic development tools identified during phase I. The program shall be tested using an actual module test development identified by the government at the start of phase II.

PHASE III: The tester simulation teals and environment may be developed as a fully documented and supported toolset for use on CASS test development systems. This toolset would be made available to DOD and commercial industries to increase efficiency in all government and commercial test program set development. The Cooperative Engagement Capability (CEC) program will use this toolset in the development of a commercial off-the-shelf (COTS) circuit card assembly.

COMMERCIAL POTENTIAL: The same automated diagnostic tool suite used by the Navy will be used by many commercial companies in the electronics industry. The new methodology could be applied to COTS circuit card assemblies in particular,

and be available for all test program set developments in the future for both commercial and DOD industries.

N95-203 TITLE: Improve Thermal Efficiency of Microwave Transmit/Receive Modules

OBJECTIVE: Improve the thermal efficiency of microwave transmit/receive (T/R) modules by applying improved materials or altering the manufacturing process.

DESCRIPTION: T/R modules are solid state devices incorporating amplifiers, phase shifters, and detector/receiver circuits in a single hermetic package for use in radio communications. Current technology of T/R modules yields an operating efficiency of roughly 30% causing the modules to run extremely hot, especially when designed for significant transmit power. Since this power loss is usually concentrated in small areas in the T/R modules, there is significant localized heat buildup that degrades the services. Cooling techniques that dissipate this heat buildup must be improved to allow for more powerful T/R modules.

PHASE I: The contractor shall investigate the various available cooling techniques applied in high power electronic devices and research the possible application of these techniques to the production of T/R modules. The contractor shall produce a report summarizing tradeoffs in available cooling techniques and suggest the best methods for application in T/R modules. Tradeoffs shall include cost, producibility and effectiveness.

PHASE II: The contractor shall develop a demonstration prototype T/R module using the improvement. The demonstration shall be tested for operating efficiency and thermal performance in contrast to the existing T/R module design. Results shall be summarized in a report.

PHASE III: The improved thermal T/R module may be developed for production and integrated in existing communications systems.

COMMERCIAL POTENTIAL: Commercial communications systems will benefit from improved thermal performance of T/R modules since this will allow for application in areas previously possible only for other technologies. Improvement in the thermal efficiency of T/R modules will allow greater packaging efficiency, reducing the cost of materials and assembly making them more attractive to commercial communications markets. Microwave T/R modules are critical to active aperture array technology. Synthetic aperture technology has already been use in nonmilitary applications such as radar terrain mapping, and can expect much wider use in commercial radar when the technology problems are resolved. T/R modules eliminate the need for microwave tubes and waveguides and can improve reliability and performance.

N95-204 TITLE: Develop Robust Nonlinear Control Technology

OBJECTIVE: Develop robust nonlinear control techniques to improve robotic control systems for application to future highly agile missile interceptors.

DESCRIPTION: The Navy needs an advanced controller for future ship defense missiles which will emphasize nonlinear techniques to control missile agility and responsiveness. The engagement of rapidly maneuvering anti-ship missiles cause the need for defensive missile operation in widely varying altitudes which are characterized by high angles of attack, and nonlinear control performance due to saturation and hystoresis effects. Nonlinear operation of electric motor actuators, hydraulic actuators, and hot and cold gas driven control actuators is expected. Robust, nonlinear design methods shall be developed for a very agile, fully coupled, multi-channel missile control system. The primary goals will be to minimize cross coupling effects and to enhance tolerance to aerodynamic uncertainties, environmental errors and unmodeled flexible mode dynamics.

The design methods should be modeled into algorithms which can be demonstrated by computer simulation. Emphasis will be placed on reducing control complexity and the ability to execute control functions for real time implementation in a missile flight computer.

PHASE I: Design and develop and report control system techniques and demonstrate their effectiveness in a computer simulation.

PHASE II: Design and produce an optimum controller for Navy targets and Navy-given flight characteristics. Build and deliver a prototype controller and demonstrate it in Navy flight tests.

PHASE III: Transition the prototype controller to support the development of a Navy highly agile interceptor missile.

COMMERCIAL POTENTIAL: Commercial uses include robotics, manufacturing, aircraft and future automobile breaking and drive train applications. Nonlinear control techniques will allow the use of smaller motors and actuators in many commercial control devices.

N95-205 TITLE: Develop a Left/Right Passive Bearing Ambiguity Resolution Sensor (BARS) for Torpedo Defense

OBJECTIVE: Develop and provide a means of instantaneous bearing ambiguity resolution for threat torpedoes at tactically significant ranges through modification of existing towed systems aboard U.S. Navy Surface Ships.

DESCRIPTION: An affordable solution to the left/right ambiguity problem is to modify existing surface ship towed equipment with an acoustic aperture designed specifically to instantaneously resolve bearing ambiguity in frequency ranges consistent with threat torpedo radiated noise. Directional sensors should be integrated into existing towed equipment. The tow cable may be redesigned to accommodate the increased data requirements. Sea test will be conducted, left/right ambiguity and detection capabilities will be determined.

PHASE I: Analytical proof of concept will be provided which models the expected performance of the bearing ambiguity resolution sensor.

PHASE II: The technology will be demonstrated at sea after modification of an existing U.S. Navy towed system.

PHASE III: The technology will transition to the fleet by incorporation of an ECP to an existing system.

COMMERCIAL POTENTIAL: A BARS sensor can provide a low cost, time saving method of locating and monitoring populations of aquatic life, such as fish or shrimp. Such a sensor could also be used for navigation and vessel identification in heavy shipping areas or in operations such as drug interdiction. Locating other sound producing sources, such as underwater fissures, provides another potential application.

N95-206 TITLE: Develop and Produce High Precision Sensors for Under-Ice Submarine Operations and Unmanned Undersea Vehicle (UUV) Missions

OBJECTIVE: To develop and provide precision gravity and other passive sensors to meet military and scientific needs. Identified Military needs include (1) precision navigation for under-ice submarine operations, and (2) navigation, positioning, and localization for UUV missions. Specific scientific needs include (1) oil exploration and (2) precious metals and minerals (specifically diamond) exploration (3) studying the earth's topography and (4) developing more accurate atlases. In spite of the high potential pyoff, the industrial sector has not made a significant investment in development of gravity or other precision sensors because of the high technological risk, and have relied heavily on Military development efforts, but quickly exploit new technology when it is proven.

DESCRIPTION: Development of a navigation system that does not rely on radio-frequency (RF) energy and will be capable of supplying submarines with own-ship under-ice geographical fix information. Gravity sensors, as one example, provide two key features for submarines and UUVs: (1) They can determine the gravity deflection caused by a certain region to assist in reducing velocity error growth that occurs in inertial navigation systems, and (2) They can sense gravity fields in a region and match that to a priori maps to perform navigation, positioning and localization. Gravity sensors will also provide a necessary component for an on-board map creating ability. The gravity system is completely passive and can be utilized during all modes of operation. Other innovative solutions are also solicited. The challenge is to develop a high precision sensor that can be effectively utilized by submarines and/or UUVs.

PHASE I: Design and develop a three axis gravity sensor with a very high precision sensitivity rating for either or both platforms.

PHASE II: Fabricate and perform an in-water test with a fully integrated gravity/inertial navigation system.

PHASE III: Integration of fully integrated gravity/inertial navigation system into submarine or UUV.

COMMERCIAL POTENTIAL: The development of this system should have a direct application to the safe navigation of arctic and other waters by commercial ships including tankers and fishing vessels. Natural Resource exploration, which includes oil and precious metals, depends on high sensitivity gravity measurement. Also, air, land, and undersea mapping requires a high precision gravity sensor to accurately determine topography.

N95-207 TITLE: Develop and Produce High Resolution Image Processing with a MidFrequency Active Sonar

OBJECTIVE: The objective is the development and application of commercially available sidescan and sonar synthetic aperture technology for the Navy's surface ship midfrequency, hull mounted active sonar to provide a capability to do high resolution

imaging of submarines and small objects on the ocean bottom in shallow water.

DESCRIPTION: Navy midfrequency sonar was originally designed to be a deep water submarine detection, classification, and localization system. Such sonar is now also required to operate in shallow waters with specific emphases on submarines and small object avoidance. To fully achieve these goals requires increased azimuthal resolution. Such resolution has been demonstrated at higher frequencies by commercially available sidescan sonar and synthetic aperture technology. It may be more efficient and cost effective to adapt this commercial technology to the Navy needs than to redesign existing sonar. The innovation needed is to modify the commercial technology to operate at the lower frequencies and longer ranges associated with Navy tactical sonars.

PHASE I: Verify the applicability of Navy midfrequency sonar as a shortrange imaging sonar, identify relevant existing sonar imaging techniques such as sidescan sonar and synthetic aperture imaging, and determine the feasibility of using an existing hull mounted active sonar source over its entire transmit band in concert with a midfrequency line array receiver to image shallow water ocean bottom and midwater column objects at short ranges. Waveform(s), transmission parameters, and processing algorithms will be defined. A plan for follow-on at sea data collection, algorithm development and performance demonstration will be generated.

PHASE II: Implement system and conduct performance demonstration sea trials. Implement required transmit waveform generation and processing and display algorithms for insertion into a midfrequency active adjunct processor or equivalent commercial platform. Conduct sea trials. Analyze performance of system and write final report with recommendations for fleet transition.

PHASE III: Develop an Engineering Change Proposal for a high resolution imaging adjunct processor for a Navy midfrequency sonar.

COMMERCIAL POTENTIAL: A successfully modified Navy sonar would be suitable for applications such as searching broad areas for underwater hazardous waste sites.

REFERENCES:
1. E.T. Sullivan, W.M. Carey, and S. Stergiopoulos, Eds., "Special Issue on Acoustic Synthetic Aperture Processing", IEEE Journal of Oceanic Engineering, vol. OE-17, Jan 1992
2. W.K. Stewart, M. Jiang, and Martin Marra, "A Neural Network Approach to Classification of Sidescan Sonar Imagery from a Midocean Ridge Area", IEEE Journal of Oceanic Engineering, vol. OE-19, pp. 214-224, April 1994
3. P.N. Denbigh, "Signal Processing Strategies for a Bathymetric Sidescan Sonar", IEEE Journal of Oceanic Engineering, vol. OE-19, No. 3, pp. 382-390, July 1994

N95-208 TITLE: Develop and Produce a SSTD Launch Canister

OBJECTIVE: Deign, develop and demonstrate the technology for a conceptual modular, low cost, quick response launcher for Anti Submarine Warfare (ASW) and Countermeasures requiring spin on automotive air bag technology. This launcher would require minimal maintenance and produce no environmentally hazardous byproducts.

DESCRIPTION: Conduct a proof of concept demonstration for a modular gas generator launch system for Surface Ship Torpedo Defense (SSTD) and other over the side launched weapons and countermeasures. The gas generator is to be a direct spin on application of existing and developing automotive passive restraint technology. It benefits the launcher design by permitting a low cost, low maintenance system that produces no environmentally hazardous byproducts. It will also permit SSTD capability to be applied to ship classes that do not have and will not require torpedo personnel as part of the standard crew, such as amphibious assault craft or high value supply ships. This technology has further potential application to the launch of submarine countermeasures, where environmental hazards are of current concern.

PHASE I: Proof of concept analysis will include the marrying of gas generator mathematical models with Navy launch models and conclude with a power requirement study including identification of required modifications to existing commercially used automotive hardware or possibly the use of multiple units through a control system.

PHASE II: The technology will be demonstrated by utilizing a single commercially available off the shelf gas generator to conduct a scale model launch of an SSTD.

PHASE III: Scale up to production baseline prototype.

COMMERCIAL POTENTIAL: The Navy has a high interest in this technology. The gas generator launch system would provide a low cost/low maintenance alternative to existing hardware. A Navy Program office has expressed a willingness to

support and transition any efforts in this area, should the technology prove feasible. Civilian potential for the technology includes: optimization of gas generators formore reliable automotive air bags or similar devices; launching a variety of devices, for example distress beacons, recreational gliders, nets for fishing, crowd control, or wild animal capture.

REFERENCES:

1. Mechanical Engineering Magazine, January 1994, "Automotive Safety is in the Bag", Steven Ashley (Associate Editor), pp. 1723.

N95-209 TITLE: Develop New Towed Array Technology

OBJECTIVE: Develop new technology for improvements and enhancement of towed array systems.

DESCRIPTION: Innovative approaches for the design, development and deployment of towed array systems are required in response to changing operational requirements. Towed array technologies are being sought which emphasize commonality with application to both surface and submarine platforms. Requirements for enhancement to towed array systems include development of a means of controlling the depth of a towed array to make it tow above and below submarine depth and to allow towing in shallow water; development of miniature sensors for use in towed arrays; towed array receiver design; signal processor enhancements; and mechanical aspects including fill fluids, hose materials and handling & stowage. The types of cables used to carry towed array electrical signals include: multi-filament; optical fiber cables; hybrid copper; coaxial cables; and multi-strand copper cables. Sensor technologies include: acoustic, magnetic, electric field, navigation, depth, tension, and temperature. Desirable characteristics of sensors include: small size (<1 cm diameter), high sensitivity, high dynamic range (>100 dB), and high bandwidth (>10,000 Hz). Signal processing techniques include: programmable beamforming, frequency spectral analysis, cross correlation, spatial and temporal filtering, replica correlation, amplitude shading, automatic gain control and noise averaging. Fill fluids must provide excellent insulation, be compatible with other materials, have a lower specific gravity than water, be non-flammable and non-toxic. Array handling and stowage systems must provide a reliable means to deploy, retrieve, and stow towed arrays with minimum impact to ship operations, requiring minimal manual labor and preventing damage to sensitive array components. Affordability is a significant issue in towed array design. Designs should consider the application of previously designed and developed commercial technology and Navy technology to towed array systems.

PHASE I: Develop sufficient data to demonstrate the feasibility of the proposed design. Provide a preliminary design for prototype system/subsystem.

PHASE II: Fabrication and demonstration of prototype system/subsystem.

PHASE III: Products and technologies of this SBIR will be evaluated for applicability to towed array programs.

COMMERCIAL POTENTIAL: Commercial potential for technology developed under this SBIR is dependent on the technology developed and includes: oil exploration, underwater inspection services, process control, and electrical power monitoring and control.

N95-210 TITLE: Develop and Demonstrate Active Sonar Target Motion Analysis

OBJECTIVE: To develop and demonstrate recent Navy techniques for Target Motion Analysis.

DESCRIPTION: The Navy has recently identified several TMA enhancements which offer significant improvement in solution quality and weapon placement accuracy. These techniques include Doppler enhancement, acoustic data sensor weighting by SNR, variable averaging periods, overlapping averaging periods, assigning solution qualities and independent parameter verifications. Continued development, intelligent application and integration of these techniques will be the focus of this work.

PHASE I: Analyze and extend and develop the available techniques for Sonar Target Motion. Implement techniques and run simulated TMA scenarios to establish estimated solution quality enhancements. Investigate and test new TMA techniques in addition to the available techniques.

PHASE II: Plan, simulate, generate and evaluate a comprehensive TMA prototype software package. Run a formal demonstration against existing Fleet TMA programs to establish the level of solution quality enhancements and any areas needing further improvement.

PHASE III: Perform a full TMA demonstration will be performed on a Navy ship during a sea test or other Navy operation. The crew of the test ship will be trained with the new crew training package and the crew will participate in the demonstration.

COMMERCIAL POTENTIAL: This work will have excellent commercial application. Areas such as port authority harbor management, air and ground airport tracking, automatic collision avoidance for merchant shipping and fish school motion analysis for commercial fishing will be able to use many components fo this development effort.

N95-211 TITLE: Develop a Surface Ship Acoustic Countermeasure (CM)

OBJECTIVE: Develop and provide a semi-autonomous water craft deployable from U.S. Navy surface ships including an integrated payload of Acoustic Countermeasures (ACM) to distract, deceive or otherwise defeat acoustic homing torpedoes.

DESCRIPTION: Surface Ship acoustic countermeasures other than towed acoustic countermeasures have been borrowed from submarine developments. The Surface Ship does not have the same size constraints as does the Submarine. Therefore, it is possible to use a small water craft in conjunction with existing amplifiers, communication, navigation, and underwater sound projector hardware to create a low cost and high performance acoustic countermeasure. The countermeasure should be able to tow its transducer at approximately 15 Knots and through the use of GPS navigation, proceed to points directed from shipboard systems. A digital communication link from the ship would supply the countermeasure with navigational instructions and transmit waveforms. The CM should be small enough to be dropped from the ship automatically and easily brought back onboard for refueling or recharging.

PHASE I: Develop and complete initial design to a level expected at Critical Design Review (CDR).

PHASE II: The design will be completed and the prototype built. The prototype will be tested at sea by the Navy.

PHASE III: The technology will be transistioned to the fleet by incorporation of an ECP to an existing system.

COMMERCIAL POTENTIAL: The small autonomous surface craft and its related control system could be useful in many commercial areas including rapid underwater contour mapping and underwater salvage.

N95-212 TITLE: Develop Mission Adaptable Control Strategies for a Resilient Unmanned Undersea Vehicle (UUV) Control System

OBJECTIVE: Develop and demonstrate a unified and mission adaptable control strategy for a tactical UUV that could be field reconfigured for a range of tactical missions.

DESCRIPTION: An innovative and cost effective solution to provide a high level intelligent controller for tactical UUVs is sought. This control system must be adaptable to tactical sensor changes, a wide range of mission profiles, operational environments and mission priorities. The control system must provide the resiliency necessary to maintain its own integrity in event of computational hardware or software degradation or failure while continuing to accomplish primary mission objectives even under adverse environmental conditions and UUV subsystem/component degradation or failure. While the Navy and its contractors have evaluated many control system architecture and control techniques, including closed equation algorithmic, neural networks, fuzzy logic algorithms and knowledge or rule-based decision trees, no single approach has proved to be satisfactory even for relatively simple missions and vehicles. A more satisfactory solution may be found by blending control techniques in a unified control concept that can be varied from mission to mission to provide adaptive and resilient control of the vehicle and its subsystems. It is mandatory that any of the control/decision processes be executable on a single hardware configuration using commercial-off-the-shelf hardware and standard, well-supported, operating system and application software.

PHASE I: Develop and analytically demonstrate the feasibility of the concept.

PHASE II: Demonstrate adaptability and resiliency via laboratory simulation.

PHASE III: Produce and integrate the control system into a Navy UUV water validation.

COMMERCIAL POTENTIAL: The Navy has a strong interest in using UUV technology for mine warfare, tactical oceanography, ASW surveillance and intelligence gathering missions. Commercial applications for long endurance UUVs include the areas of pipeline inspection, underwater structure damage assessment, pollution detection/mapping, resource exploration/mining and a host of other underwater missions not suitable for ROVs (tethered UUVs) or manned submersibles.

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND

N95-213 TITLE: Shipboard Production of Intravenous Fluids

OBJECTIVE: A preproduction prototype of a device capable of meeting Food and Drug Administration (FDA) licensing criteria, that uses shipboard potable water and electrical power to produce properly labelled and filled bags of United States Pharmacopeia(USP) quality intravenous fluids.

DESCRIPTION: There is an urgent need to increase the immediate availability of intravenous solutions aboard ships and to reduce strategic transportation requirements to maintain resupply of these fluids. There is currently no onsite production capability, and no commercially available device exists to meet the need. The system must produce USP quality fluids for injection using U.S. Navy shipboard potable water as the input source. Minimal output should be 36 one liter bags/hour, with an ideal rate of 46 one liter bags/hour. Software and hardware should be compatible with a sterile means to add concentrates to generate (a) isotonic sodium chloride USP (0.9%) in one liter bags, (b) lactated ringer's USP for injection in one liter and half liter bags, (c) sterile water for injection USP in one liter bags, and (d) sodium chloridedextrose solution for deglycerolization of thawed previously frozen red blood cells in three liter bags. The system must make a label meeting FDA standards for each bag of fluid produced. Concentrates must be packaged in FDA approved bags which have a shelf life of at least two years (optimally 3 years) and special identification markings to prevent accidental use during patient care. Bags must be packaged to enable a shelf life of 6 months at a temperature range of +1 Cx to +50 Cx. The system must have a builtin quality control system to monitor and control system integrity throughout the production cycle. The equipment must operate from 110 q 15% volt alternating current 60 Hertz q 2 hertz, with a power requirement of 10 kilowatts or less. The system must meet USN requirements for shipboard space and weight limitations, for electrical safety aboard ships, and function equally well during conditions of moderate vibration, roll, pitch and yaw as when used on a stable platform. Minimal mean time between operational mission failures should be 125 hours (objective = 250 hours),minimal operational availability should be 80% (objective =89%), and mean time to repair should be s 2 hours (objective = s 1.2 hours). Device design should enable local repair with spareparts, consistent with the isolated operational environment. The system should be designed to be operated by one individual with a skill level commensurate with that of a pharmacy technician.

PHASE I: Deliver document which includes (a) detailed analysis of alternate engineering solutions, justifying the selection of the preferred strategy for a prototype device, (b) detailed plans for implementing the selected strategy, including time course for accomplishment, scheme to address critical pathway decisions (including FDA licensing issues), and (c) cost to deliver an engineering prototype device.

PHASE II: Fabricate and deliver an engineering prototype device that meets required specifications

PHASE III: Accomplish test and evaluation of the engineering prototype, pre-market approval discussions with the FDA, and make the required modifications that result in the delivery of a preproduction prototype device.

COMMERCIAL POTENTIAL: This device is likely to have wide commercial application in the medical treatment infrastructure in remote locations of developed countries, and in third world and developing countries with limited transportation capability. The weight and volume of bag sets and concentrates is only a small fraction of the weight and volume of the equivalent number of full bags of solutions ready for infusion. The device will also be valuable in mass casualty scenarios involving trauma (e.g. earthquake relief) or infectious disease (e.g. epidemic diarrhea).

REFERENCES:

1. U.S. Army Medical Materiel Development Activity "Resuscitative Fluids Production and Reconstitution System (ST) Milestone IIIa In-Process Review" of December 1993.

N95-214 TITLE: Portable Rapid Tests for Diagnosis of Campylobacter Enteritis and Shigella Dysentery in Operational Ship and/or Field Environments

OBJECTIVE: Development of portable, rapid diagnostic tests for the field and shipboard detection of enteropathogenic Campylobacter and Shigella in fecal specimens.

DESCRIPTION: Acute infectious diarrheal diseases comprise the single greatest medical threat to Navy and Marine Corps personnel serving overseas. Numerous bacterial, viral and parasitic agents are known to cause periodic diarrhea outbreaks, but enterotoxigenic Escherichia coli, enteropathogenic Campylobacter and Shigella bacteria have been most frequently recovered from deployed forces experiencing acute episodes of diarrhea or dysentery. Although all of these pathogens have missionabortive

potential, illnesses caused by Campylobacter or Shigella are the most severe. Both pathogens invade intestinal tissues, causing fever and bloody diarrhea. In field situations, laboratory diagnosis is usually not possible because the necessary materials and equipment are generally not transportable, and because performance of conventional tests require a high degree of specialized skill. Clinically, these agents cause disease which is easily confused with other febrile illnesses, such as malaria and dengue fever. Without an accurate laboratory diagnosis, treatment of severe cases can be complicated because the genera differ significantly in antibiotic susceptibility profiles. A rapid and relatively simple diagnostic assay that identify these two invasive bacteria in stool samples would be of immense clinical and operational value, minimizing the impact of enteric illness on combat readiness by facilitating early and appropriate treatment.

PHASE I: Develop prototype tests based on different antigen detection systems. Emphasis should be placed on the development of diagnostic reagents for the detection of clinically relevant antigensthat will be highly specific for the bacteria of interest, yet have the ability to distinguish the most pathogenic
phenotypes within each group. Tests will be formatted for minimal specimen preparation and equipment/ electrical support.

PHASE II: Refine and optimize assay conditions and reagents, evaluating both polyclonal and monoclonal assay systems. Further test candidate assays in animal models of disease. Based on animal modeling results, select the most sensitive and specific test formats for reformatting into kits and followon clinical and field testing.

PHASE III: Evaluate prototype kits in field and shipboard environments. Select optimum assay system for transitioning to advanced development.

COMMERCIAL POTENTIAL: In the U.S. alone, Campylobacter is responsible for 2.5 million cases of diarrhea annually. Globally, the organisms cause disease in at least 400 million persons per year and they are the second most common cause of travellers' diarrhea among international travelers. Shigella is a leading cause of childhood mortality in the developing world, but is also responsible for large numbers of outbreaks among persons of all ages in the U.S. and Europe. The development of a simple and rapid test for the early diagnosis of these infections would be of significant commercial value, as well as a major public health benefit, serving to reduce childhood mortality worldwide and lessening the economic impact of severe adult diarrhea.

REFERENCES:
1. Taylor, D.N. Campylobacter infections in developing countries. In: Campylobacter jejuni: Current Status and Future Trends (Eds. Nachamkin, I., Blaser, M.J. and Tompkins, L.S.) Amer. Soc. for Microbiol., Washington, D.C. 1992, pp 2030. ADA254386
2. Haberberger, R.L. and Walker, R.I. Prospects and problems for development of a vaccine against diarrhea caused by Campylobacter. Vaccine Res. 1994, 3, 1522 ADA279218
3. Keusch, G.T. and Bennish, M.L. Shigellosis: Recent progress, persisting problems and research issues. Pediatr. Infect. Dis. J. 1989, 8, 713719

N95-215 TITLE: Optimization of Casualty Handling

OBJECTIVE: Determine the applicability of modeling and simulation to the representation of the logistics of medical emergencies.

DESCRIPTION: Emergency medical treatment of mass casualties is a classic example of a system stressed by surge inputs with the need to optimize resources. A mass casualty situation at sea is further compounded by an operating environment that is severe and demanding, including loss of the medical treatment facility and the possible injury or death of medical providers due combat damage or loss of a vessel. Regardless of operating environment, the medical requirement in a mass casualty situation is to move patients through a triage system to appropriate care providers and echelons of medical care. Modeling and simulation tools can be used to investigate and assess medical system options and their efficacy in treatment of surge casualty situations. Current object oriented and intelligent agent programming paradigms can be used to develop computer simulations that would support dual use military and civil applications. Such a simulation would be useful in the assessment and enhancement of current care systems, in the design of new systems, and for training of care providers in a synthetic environment setting.

PHASE I: Develop a preliminary PCbased simulation to assess medical operations in a naval environment. The simulation system must at a minimum incorporate models of the medical care system, enemy threat, shipboard damage and casualty production.

PHASE II: Deploy at least two of prototype system that are Distributed Interactive Simulation (DIS) compliant for field testing.

PHASE III: Conduct field testing and evaluate prototype system.

COMMERCIAL POTENTIAL: This prototype, which incorporates mass casualty models and simulations, has the potential for application as a training and as a planning system for disaster relief as well as city emergency services personnel.

REFERENCES:
1. Alluisi, E.A. "The development of technology for collective training: SIMNET, a case history," Human Factors, vol. 33, no. 3, 1991, pp. 343362.

NAVAL SUPPLY SYSTEMS COMMAND

N95-216 TITLE: Articulated Instrumented Manikin

OBJECTIVE: To develop a durable, fire retardant, variable speed, articulated, anthropometrically correct, instrumented manikin.

DESCRIPTION: There exists a need for a durable, fire retardant variable speed, articulated, anthropometrically correct, instrumented manikin to simulate a six foot tall, size 40 Regular, muscular well conditioned adult male. The manikin will be used to measure the burn injury potential of fire retardant clothing worn by a person escaping a shipboard fire. The manikin shall possess the capability of obtaining measurements with up to 110 total heat flux transducers or skin simulants, with access points for repairs at the center back, upper arm, forearm, thigh, and calf. The internal wires from the sensors will exit the manikin through a molded aluminum pipe located in the head of the manikin. The hands and feet of the manikin will be solid, and not possess any sensors. The sensors shall be mounted as flush as possible with the fiberglass exterior of the manikin. The distribution of the sensors shall be approximately one per unit surface area. The system shall have the flexibility to disconnect any sensors not necessary for any one particular test run. The manikin will be suspended from a variable speed traversing system. The manikin will be fire resistant and durable to withstand multiple large scale fuel fire envelopment at exposure levels of 2.0 to 5.0 gram calories per square centimeter. The manikin system will be exposed to these heat levels for short periods of time, typically five seconds or less. The manikin shall be articulated in such a way that while passing through the fuel fire via a variable speed traversing system, the manikin will simulate a walking to running motion of the arms, legs, and torso.

PHASE I: Research means to develop the system and test the components to see if they meet the requirements.

PHASE II: Develop prototypes for testing and approval.

PHASE III: Successful testing of the operation of the system will be conducted prior to final approval by the Navy.

COMMERCIAL POTENTIAL: Both state and local governments and private sector would receive major payoff from new specifications and products (such as clothing, etc.) derived from the knowledge gained from enhanced thermal simulations.

REFERENCES:
1. Dale, J.D., E.M. Crown, M.Y. Ackerman, E. Leung, and K.B. Rigakis (1992) "Instrumented mannequin evaluation of thermal protective clothing". In J.P. McBriarty and N.W. Henry (Eds.), Performance of Protective Clothing, Fourth Volume, ASTM STP 1133, Philadelphia: American Society for Testing and Materials.
2. Crown, E.M., Dale, J.D. "Built For The Hot Seat" Canadian Textile Journal, March 1993.
Brown, W., ASTM Subcommittee F08.53.02, "Athletic Equipment that Helps Prevent Cervical Spine Injuries Via Hybrid III Anthropomorphic Test Devices (ATD)" ASTM, Philadelphia (215/2995499). ASTM Standardization News, April 1994.

N95-217 TITLE: Active Thermal Absorbing/Insulative Materials

OBJECTIVE: To reduce the heat transfer rate through fire fighter's clothing to allow longer exposure time for fighting the fire without increasing weight or decreasing the functionality and durability of the overall garment system.

DESCRIPTION: Tolerance time of the firefighter is currently limited by the rapid rate of heat transfer through the fire fighter's clothing which leads to discomfort, heat stress and potential burn injury.

PHASE I: The contractor shall develop a minimum of three specific durable liner materials which exceed the thermal performance characteristics of the current battings, by specifically reducing the heat transfer rate and also meeting or exceeding all other physical characteristics applicable to liner materials. The contractor shall also provide supporting data to prove efficacy

of those materials for use in fire fighting clothing, conforming to National Fire Protection Association Standard (NFPA) 1971 for thermal barrier material. Deliver one square yard of each of the prototype materials practical for use in garments and of a width required to perform tests specified in NFPA 1971.

PHASE II: The contractor shall optimize prototype materials identified in Phase I for human factor acceptance. Produce ten fire fighter's garment liners from each of the two best candidate materials developed in Phase I. Government accepted garment patterns and construction techniques shall be used. Provide data pertaining to thermal protection results, cost effectiveness and manufacturing viability for the intended application.

PHASE III: The contractor shall finalize manufacturing methods and cost effectively deliver 100 fire fighter's garment liners fabricated from the selected material.

COMMERCIAL POTENTIAL: Tremendous potential exists to transition this technology to all military services and the private sector fire fighting community and to any application requiring enhanced thermal protection.

REFERENCES:

1. NFPA 1971/1976

N95-218 TITLE: Application of Neural Networks for Pattern Recognition in Logistics Data

OBJECTIVE: Develop techniques for the application of Neural Network technology against large transaction history data bases to identify complex patterns not currently considered in logistics math models. The development process will include specific application to Navy Logistics history records and inventory records with the intent of establishing improved criteria for the management of spare parts and repairables based on currently unseen patterns in past transactions. Development will necessarily include procedures for development of the initial pattern recognition neural network, "training" the network with data base records, and operational procedures for the system in a LAN environment. It is intended that this technology will be combined with the use of PC/LAN/multi-processor technology to process large data bases and computation intensive tasks on a client-server basis; and with standard object oriented application development tools (such as visual basic and visual C) providing a standard use software.

DESCRIPTION: Neural network technology has been used successfully for complex pattern recognition applications. Standard forecasting techniques involve the processing of large amounts of data base information and complex mathematical functions, but cannot take into account the more complex patterns caused by changes in maintenance plans, fleet operations, tempo of operations, mission assignments, operating hours, etc. While these may be adjusted for and managed well by the human involvement in Supply Management, the experience and capability to plan is lost, or at least diminished, when the person changes. The development of Neural Network technology to recognize these complex patterns and relationships can provide improved planning tools and forecasting capabilities. As the capability to efficiently handle large data bases has improved and as processing power increases, the use of such complex tools becomes possible and effective.

PHASE I: Conduct a six month study of UICP, DLA, and CNO data base records and current processing capabilities. Review computing requirements for utilization of Neural Network technology. Develop a plan for establishment of a suitable pattern recognition Neural Network and for the further training of that network with the data base records that are available. The plan should include details for maximizing the use of current LAN processing capabilities, and a theoretical proof of the technology's capability to improve on current forecasting.

PHASE II: Develop and refine the system to provide improved forecasting accuracy, timeliness of procurement, and location of assets. Deliver and train a Neural Network based on the plan developed in Phase I. Conduct a comparative study of the technology against current forecasting techniques.

PHASE III: The processes and programs will be fully documented and transitioned into full use. Procedures for development of other applications will be provided for Navy use. Key Navy personnel will be thoroughly indoctrinated into the application techniques used.

COMMERCIAL POTENTIAL: The technology has significant commercial possibilities for the recognition of complex patterns within business and economic systems; and specifically in inventory management.

NAVAL SURFACE WARFARE CENTER/SSPO

N95-219 TITLE: Thermal Management for Strategic System Nosetips and Leading Edges

OBJECTIVE: Develop ablation-resistant nosetip and leading edge materials/systems for use in high-heating-rate environments.

DESCRIPTION: Current strategic system reentry bodies (both Navy and Air Force) utilize ablative materials for the nosetips. Advanced materials and/or thermal management systems are believed to be needed to provide ablation-resistant response and, thus, to provide future system accuracy and performance needs. A possible solution approach is the combination of an ultra-high-conductivity material (such as diamond) with a thermal management system (such as a heat pipe). It is emphasized that high reliability is required, which suggests solution approaches which are passive, simple, self-contained, and possess long shelf-lives.

PHASE I: Identify one or more ablation-resistant nosetip/leading edge concepts. For the materials selected, chemical stability shall be shown for all materials and material interfaces (internal and external) through the range of temperatures to be experienced.

PHASE II: Technology areas critical to the prediction of acceptable performance and to the construction and demonstration of a ground-test article are to be completed. Given suitable flight trajectory parameters, design calculations are to be performed to identify the final design of the demonstration article to be fabricated in Phase III.

PHASE III: Fabricate and conduct arc-heather (and other, as necessary) ground testing of the nosetip/leading edge design produced in Phase II.

COMMERCIAL POTENTIAL: Applications which require management of high heat fluxes would benefit from the materials or systems developed. For example, thrusters on satellites or their launch vehicles or on the leading surfaces of future hypersonic air vehicles. Also, these may provide a thermal management system for advanced, high temperature gas turbine or internal combustion engines.

REFERENCES:
1. Kardell, M.P., et al., "Arc-Heater Ground Testing of Oxidation-Resistant Carbon-Carbon Materials," NSWC TR 87-32 (Feb 1987). (Avail DTIC).
2. Baskin, Y., et al., "Failure Mechanisms of Solid Propellant Rocket Nozzles", Ceramic Bulletin, vol. 39, no. 1, (1960), pp. 14-17.
3. Campbell, J.G., "Refractory Chamber Materials for N2O4/Amine Propellants", AFRPL-TR-73-1 (May 1973). (DTIC AD-762531)

N95-220 TITLE: High Definition Spatial Light Modulators for Displays Methods

OBJECTIVE: The development of a high definition, high speed spatial light modulator and its demonstration in a two-dimensional display.

DESCRIPTION: Improved spatial light modulators that convert electrically stored information into parallel coherent images are critical in the development of a high definition, high speed, two dimensional display and image correlation. Unfortunately, current technology based on liquid crystals provides inadequate performance. New optical materials, such as inorganic Electron Trapping Crystals, combined with new device structures or operating principles are needed. Design goals include a resolution of 1024 x 1024 pixels with 256 gray levels, a contrast ratio greater than 10,000 to 1, a frame rate of at least 100 kilohertz and the capability to operate between 450 and 1350 nanometers.

PHASE I: Identify optical materials and predict performance in a spatial light modulator. Design a high definition, high speed modulator for use in a display and in image correlation.

PHASE II: Optimize modulator design for a Navy display application. Construct prototype and provide laboratory demonstration of performance.

PHASE III: Transition to an Advanced Development Program which includes improved displays and/or correlators.

COMMERCIAL POTENTIAL: Advanced displays needed in medical image analysis, security surveillance, machine vision systems and high definition projection systems. Spatial light modulators used in optical data processing, optical pattern recognition and fiber optics.

N95-221 TITLE: Software Automation for Distributed System Development

OBJECTIVE: Develop an automated software system to aid in the development and use of distributed systems and their components.

DESCRIPTION: A unified process is needed for re-thinking conventional processes in the design and building of software. The process should consider the use of some of the many computer Aided Software Engineering (CASE) tools currently available in developing a high level approach to both the design of new systems and dealing with the similarity between the definition of the software problem and its solution. Integrity and independence of components should allow the isolation of errors and the easy extension to new applications. These attributes should be combined with an appropriate human interface to provide guidance to both system developers and problem solvers.

Techniques which claim to address some aspects of above attributes include object-orientation, knowledge-based systems, concurrent engineering, rapid prototyping, executable specification, and system modeling.

PHASE I: Demonstrate the feasibility of an approach for the extended automation of software development (initial construction and subsequent evolution.)

PHASE II: Develop a prototype software automation system and assess its utility.

PHASE III: Apply to Navy applications such as fire control systems.

COMMERCIAL POTENTIAL: Commercial computer systems using client server technology

REFERENCES:

1. Case Trends, Vol 5, #3, April 1993.
2. Jim Stikeleather, "Why Distributed Object Computing is Inevitable", Object Magazine dated March/April, 1994

BUREAU OF NAVY PERSONNEL

N95-222 TITLE: Command-Level Drug Testing Strategy

OBJECTIVE: To design and develop a system for analyzing the impact of alternative command-level personnel drug testing strategies.

DESCRIPTION: Any drug use compromises force readiness and introduces additional costs to both the service member and the Navy. The Navy's zero tolerance drug policy includes a random urinalysis testing policy for all military personnel. The effectiveness of such testing would increase if commands used a selection strategy which maximizes deterrence and minimizes the time until detection.

PHASE I: Develop a methodology for determining the probability of detecting drug users under a comprehensive collection of alternative scenarios of drug use, crew composition, and testing strategies (selection of days and monthly testing rates). Develop all design specifications for incorporating this methodology into a command-level system.

PHASE II: Develop a methodology for selecting individuals in accordance with the methodologies developed in Phase I for use at the command-level. Develop all design specifications for incorporating this methodology into a command-level system.

PHASE III: Produce a marketable system for analyzing alternative drug testing policies and selecting individuals for testing at the command level.

COMMERCIAL POTENTIAL: Drug testing is gaining acceptance as a means for deterring drug abuse in the workplace. A system for analyzing the effectiveness of alternative drug testing strategies and selecting individuals based upon such analyses would be of great benefit to all commercial enterprises with random drug testing programs.

N95-223 TITLE: Adaptive Tutor for Conceptual Knowledge

OBJECTIVE: Design and develop prototype tutoring system which addresses learning, retention, and application of conceptual knowledge.

DESCRIPTION: Although the last two decades have seen increases in the sensitivity, reliability and efficiency of sensors available to Navy operators and tacticians, there has been no demonstrated improvement in the conceptual understanding of the

crew who employ them. The status quo remains, e.g., tendencies to form and disseminate misconceptions, inability to explain or predict sensor performance in unique and previously unencountered situations. There is a need for better ways to train and assess conceptual knowledge to ensure effective learning, retention, and application.

PHASE I: Design and develop a prototype tutoring system in a domain heavily comprised of conceptual knowledge (e.g. acoustical oceanography). The description of the instructional strategy is to include, but not be limited to, diagnostic learner assessment, presentation, practice, and feedback strategies and issues.

PHASE II: Continue development of the adaptive tutoring system. Use results of initial trials to modify the instructional strategies employed in the prototype tutor. Expand prototype to include additional lessons in related topic areas (e.g. atmospheric effects on RF emissions). Identify potential/target education and industry users. Develop a marketing plan.

PHASE III: Expand the tutor, using the design employed in Phase II, to address conceptual knowledge in other educational or industrial domain(s). Implement the tutor for target users.

COMMERCIAL POTENTIAL: The commercial potential for the product, if applied to the acoustical oceanography domain, is in the areas of oceanography, underwater survey and salvage and geology. General application may also be made to educational and industrial training programs.

N95-224 TITLE: A Tool for Modeling Distributed Decision Making in Complex Environments

OBJECTIVE: To develop an assessment tool to aid in the design of distributed decision making systems as well as help in determining the training requirements of such systems.

DESCRIPTION: The use of distributed decision making and various decision architectures has been documented in complex integrated work environments. Complex environments require decision support networks, centralization of data bases, and advanced communication channels. Effective systems can be designed from reliable models of the organization, environment, and distributed decision making tasks. Automation of these models is vital for analyzing advanced system needs. Automated methods are being sought that:

- Diagnose the information processing and decision making needs of a complex organizational environment.
- Identify decision architectures and communication networks that meet the decision requirements of an advanced organization.
- Prescribe and integrate strategies for effective distributed decision making in complex environments in an automated format.

The resulting automatic assessment tool will be useful in helping an organization to determine the nature and architecture of decision making systems (with emphasis on distributed system) required to optimize its effectiveness.

PHASE I: Develop and validate a model of distributed decision making that incorporates organizational, environmental, information, and communication constraints. Synthesize pertinent literature, as necessary.

PHASE II: Design and prototype an assessment tool that can aid organizations in determining the appropriate decision systems to accomplish their goals.

PHASE III: Apply the tool using military and private organizations.

COMMERCIAL POTENTIAL: This technology for distributed decision making systems can be developed to assist organizations in becoming more productive and effective.

REFERENCES:
1. RASMUSSEN, J., et al., (Eds.), 1991, Distributed Decision Making: Cognitive Models for Cooperative Work. New York; John Wiley & Sons.

NAVAL FACILITIES COMMAND

N95-225 TITLE: Eliminating Fatigue Failures in the Navy Infrastructure

OBJECTIVE: Develop nondestructive methods to quantitatively locate and size structural flaws in metals which propagate into fatigue cracks. Develop a procedure to determine the material toughness (the material's resistance to fracture) in a nondestructive manner.

DESCRIPTION: Fatigue failures in the Navy cranes pose a significant threat, especially for 1940 vintage cranes handling nuclear material during shipyard operations. The Navy has already experienced many fatigue failures in critical crane components resulting the uncontrollable dropping of the load. Current NDT fatigue crack location techniques are not suited for the inspection of many critical cranes components. Methods today are very time consuming, inaccurate and difficult to use. Many techniques utilizing emerging technology require extensive surface preparation and internal flaw detection and can only be accomplished by a scientist with years of experience and the capability to decipher the data. A nondestructive method for determining the material toughness also needs to be developed. Current techniques require large specimens to be cut out of the existing component leaving the component unable to sustain service loadings. A prospective method should be simple to operate and not require exhaustive sampling.

PHASE I: Evaluate techniques applicable to locating fatigue cracks and determining the material toughness in structural metals. Specifically address nondestructive techniques for determining the crack size, orientation and material toughness. Develop and construct prototype tools capable of quickly and accurately determining the required fatigue properties.

PHASE II: Test prototype nondestructive inspection and material toughness tools in field-like applications for their accuracy, precision, accessibility and ease of operation. Prepare a report of the findings and make recommendations for preparing the tools for field use. Complete a failure mode and effects analysis of the design, manufacturing and operational process associated with each inspection tool.

PHASE III: Construct an actual inspection tool for commercial use. Developed tool will transition to the advanced development within the Navy's Advanced Diagnostic, Structural Repair and Upgrade Program. The Navy is interested in utilizing the developed technology on its own large cranes and enter into marketing efforts with crane operations at major private shipyards.

COMMERCIAL POTENTIAL: The results of this development will provide the commercial sector with a method for an easy, cost effective procedure to locate fatigue cracks and give the engineer the material properties required to make accurate residual life predictions. No method exists today that can nondestructively obtain necessary fatigue properties.

N95-226 TITLE: Rapid Pipe Pile Cutoff Technology in Support of Amphibious Logistics Operations

OBJECTIVE: Develop the technology that can be used to cutoff steel pipe pile with a maximum diameter 30 inches within minutes. The cutoff operation will be performed on dry surface of an elevated causeway using only one unskilled laborer assisted by a crane.

DESCRIPTION: Amphibious Operations make use of the Modular Elevated Causeway Systems, ELCAS(M) to transfer containerized cargo, vehicles and materials from ships moored offshore to an unimproved beach staging area. Elevated causeways are supported by piles driven into sea floor sediments. After pile foundations are installed, top-mounted pulleys lift the causeways above the water surface. The construction of the ELCAS(M) starts from beach and extends to offshore. After a causeway is elevated, piles jutting above the elevated causeway must be cutoff to allow forklifts to transport a causeway section to the next erection. The current practice of using a welder torch to cutoff a steel pipe pile of 24-in diameter requires about 15-20 minutes. During cutting, a crane must hold the pile upright. For a 3000-feet causeway, more than 160 piles must be cutoff, meaning that the crane will be tied up for 60 hours. While the Navy has not ruled out the concept of using explosive/ shaped charges if a safety measure is developed, it would be preferable to develop a concept that would be useable in a highly congested work area.

PHASE I: Evaluate new technologies for pile cutoff. Perform engineering assessment and trade-off studies to determine the feasibility of these technologies, and recommend an optimum concept. Document the results of the engineering assessment and the trade-off study. Design, develop and construct a prototype pipe pile cutting system. Safety considerations need to be addressed in tandem with the technology development.

PHASE II: Perform prototype tests in the laboratory. Perform modifications to correct technical deficiencies encountered during the tests. Demonstrate the prototype in field tests and deliver a enhanced cutting system.

PHASE III: Develop technology transfer mechanisms such as informal seminars and presentations at trade shows. Commercial development assistance will be provided by the NAVFAC project on JLOTS Improvements.

COMMERCIAL POTENTIAL: The results of this study can be readily applied to both the onshore and offshore projects such as the construction of bridges, plants, buildings constructed on pile foundations and for various pipeline industries. The Navy is interested in applying the developed technology over a broad industrial base.

N95-227 TITLE: Portable and Light Surface Mapping/Volume Measurement Tool

OBJECTIVE: Develop an inexpensive, portable and light tool that will accurately map the surface and/or compute the volume of small depressions on the surface of cylindrical cables. The depressions would measure no larger than 20 mm by 20 mm square and 10 mm deep, and could be significantly smaller.

DESCRIPTION: In the study of undersea cable abrasion, it is necessary to measure the amount of the cable material that has been removed by a particular abrasive after a known period of time. The shape and roughness of the wear zone is dependent on a number of factors including the cable tension, the degree to which the cable is embedded in or wrapped around the abrasive, the distance the cable travels on each abrasive stroke, and the shape and hardness of the abrasive. This combination of factors makes each wear zone different. Simply measuring the change in diameter is not adequate; a tool that maps the surface of the wear zone, or at least measures the volume of material worn away, is needed. The proposed system would preferably provide readings in real time.

PHASE I: Provide a concept and investigate the feasibility of a portable and light surface mapping/volume measurement tool. Report on the technology selected and its anticipated effectiveness as part of the surface mapping/volume measurement tool.

PHASE II: Manufacture a working prototype of the tool. Thoroughly test the device in order to verify its accuracy, precision, range, and susceptibility to environmental conditions.

PHASE III: Transition the tool to SPAWARS Cable Survivability Program.

COMMERCIAL POTENTIAL: An inexpensive, portable and light, field ready surface mapping/volume measurement tool would be of use to such diverse fields as criminal forensics (studying exact shape/volumes of indentations from impacts), geology (looking at the shape/volume of samples while in the field), and the manufacturing industry (monitoring parts on the production line).

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
An original red-printed Appendix A must be included with each proposal submitted.

Appendix B: **Project Summary Form**
An original red-printed Appendix B must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD SBIR/STTR Mailing List Form**

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ______________________

____

FIRM NAME: ______________________

MAIL ADDRESS: ______________________

____

CITY: ______________________ STATE: __________ ZIP: __________

PROPOSED COST: ______________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Has this proposal been submitted to other US government agencies, or DoD components or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________________	NAME: ______________________
TITLE: ______________________	TITLE: ______________________
TELEPHONE: ______________________	TELEPHONE: ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ______________________

______________________ ________ ______________________ ________

SIGNATURE OF PRINCIPAL INVESTIGATOR DATE SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902 (Commercial)

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PROPOSALTITLE: ____

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FIRM NAME: ____

PHASE I or II PROPOSAL: ________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

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APPENDIX A

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SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
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▸ Number of employees including all affiliates (average for preceding 12 months): ____________

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(703) 274-6902 (Commercial)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSAL TITLE: ______________________

____

FIRM NAME: ______________________

MAIL ADDRESS: ______________________

____

CITY: ______________________ STATE: __________ ZIP: __________

PROPOSED COST: ______________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Has this proposal been submitted to other US government agencies, or DoD components or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________________	NAME: ______________________
TITLE: ______________________	TITLE: ______________________
TELEPHONE: ______________________	TELEPHONE: ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ______________________

______________________ ________ ______________________ ________
SIGNATURE OF PRINCIPAL INVESTIGATOR DATE SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902 (Commercial)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

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FIRM NAME: ____

PHASE I or II PROPOSAL: ________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

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MAIL ADDRESS: ____________________

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PROPOSED COST: ____________________ PHASE I OR II: ______ PROPOSAL PROPOSED DURATION: ______ IN MONTHS

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____________________ ____________________

____________________ ____________________

► Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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FIRM NAME: ______________________

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List a maximum of 8 Key Words that describe the Project.

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______________________ ______________________

______________________ ______________________

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(703) 274-6902 (Commercial)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 95.3
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________________ ____________
Signature by receiving organization Date

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires July 7, 1995, the DoD SBIR Program Solicitation No. 95.3 closing date.

REQUESTER____
Name

ORGANIZATIONNAME____________________________________

ADDRESS____
Street

____________________________ PHONE________________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1________	6________		11________	16________
2________	7________	*PLEASE TYPE OR PRINT IN THE ORDER TOPICS APPEAR IN THE SOLICITATION*	12________	17________
3________	8________		13________	18________
4________	9________		14________	19________
5________	10________		15________	20________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

User Code from current or prior solicitations (if known): ________________.

____
Signature of Requester

=======================FOLD HERE=======================

STAMP

Return Address

Defense Technical Information Center
Building 5, ATTN: SBIR
Cameron Station
Alexandria, VA 22304-6145

=======================FOLD HERE=======================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Robert Lane
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7041/7042

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 200
San Diego, CA 92111-2241
(619) 637-4922

DCMAO Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellevue, WA 98004-8019
(206) 889-7317/7318

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMAO Van Nuys
ATTN: Dianne Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158 ext. 201

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392 (ext. 231 or 229)

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6170 ext. 231

DCMAO Chicago
ATTN: James Kleckner
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1573
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318
(617) 451-3174 (FAX)

DCMAO Boston
ATTN: Phil Varney
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
c/o Defense Electronics Supply Center
Building 1, 1507 Wilmington Pike
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Garden City
ATTN: Eileen Kelly
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5722

DCMAO Grand Rapids
ATTN: Kay Hamilton
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7706/7705

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO New York
ATTN: John Castellane
201 Varick Street, Room 1061
New York, NY 10014-4811
(212) 337-0326

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburgh
ATTN: Rich Spanard
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
1125 Berkshire Blvd., Suite 160
Wyomissing, PA 19610-1249
(610) 320-5012

DCMAO Springfield
ATTN: Sylvia Liggions
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8204

DCMAO Stratford
ATTN: Otis Wade
550 Main Street
Stratford, CT 06497-7574
(203) 385-4418

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 448-7897

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Sandra Scanlon
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197
(404) 590-2110 (FAX)

DCMAO Baltimore
ATTN: Gregory W. Prouty
200 Towsontown Blvd.
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304
(205) 251-5325 (FAX)

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205
(214) 573-2182 (FAX)

DCMAO Orlando
ATTN: Victor Irizarry
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5113/5260
(407) 228-5312 (FAX)

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(210) 229-4650
(210) 229-6092 (FAX)

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Orlando Coriano
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202
(809) 784-2011 (FAX)

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

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4. TITLE AND SUBTITLE			5. FUNDING NUMBERS
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			8. PERFORMING ORGANIZATION REPORT NUMBER
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GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

Block 1. Agency Use Only *(Leave blank).*

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1Jan88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10Jan87 - 30Jun88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD5230.24, "Distribution Statements on Technical Documents."
DOE - See authorities.
NASA - See Handbook NHB 2200.2.
NTIS - Leave blank.

Block 12b. Distribution Code.

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DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
NASA - Leave blank.
NTIS - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only).*

Blocks 17 - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

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The DoD SBIR Program Office maintains a computerized listing of firms that have requested to be sent copies of the DoD SBIR Solicitations on a regular basis. If you would like to be remain or be added to this listing, please mail in this form.

☐ **YES**, Include my name and address on the DoD SBIR Mailing List

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NAME: ____

COMPANY: ____

ADDRESS: ____

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